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ON

DISORDERS

OF THE

CEREBRAL CIRCULATION,

&c. &c.

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ON
DISORDERS
OF THE
CEREBRAL CIRCULATION;
AND
ON THE CONNECTION
BETWEEN
AFFECTIONS OF THE BRAIN
AND
DISEASES OF THE HEART.

BY

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PREFACE.

The present volume does not pretend to be a complete treatise on the subjects which are discussed in its successive sections. The mass of the materials of which it is composed formed the substance of the Lumleian Lectures delivered at the Royal College of Physicians in the months of February and March 1843 and 1844. The first series of Lectures was afterwards published in the London Medical Gazette (May 1843). The physiological and pathological doctrines advanced in those lectures attracted the attention, and subsequent favourable notice, of many whose opinions the author highly valued*.

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* Vide Lectures on the Practice of Physic By T. Watson, M.D. Vol. i. 2d Edition.

Physiological Anatomy of the Brain, &c. By R. B. Todd, M.D. F.R.S. London, 1845. Page 249.

Principles of Medicine. By C. J. B. Williams, M.D. Page 126.

Report on the Progress of Anatomy and Physiology in 1843-44. By William Budd, M.D.

Report on the Progress of Human Anatomy and Physiology in the Year 1842-3. By J. Paget, Lecturer on General Anatomy and Physiology at St. Bartholomew's Hospital.

Encouraged by such authorities, it appeared more advisable, instead of publishing the second series of lectures isolated from the first, to revise both series, and submit them, as a connected whole, to the consideration of the medical profession.

Although the following physiological, pathological, and practical essays were delivered in the form of lectures, it must be mentioned that the audience to whom they were addressed was composed of persons well versed in the different subjects discussed, and hence all elementary matter was avoided as much as possible. Each subject was touched upon only in reference to those parts of it where the author supposed he had some novelty to communicate, or where he thought there were erroneous opinions to be combated, or where he hoped to be able to offer suggestions which might lead to the more successful treatment of the diseases into the history of which he had entered.

The circumstances just alluded to will account for an unavoidable incompleteness in treating the topics which form the subjects of several sections. But as the original courses of lectures were not designed for the systematic instruction of beginners, so the present work is rather addressed to those members of the profession who may have adopted opinions relative to the physiology and pathology of the brain which the author deems erroneous.

In the first three sections the author has endeavoured to establish more correct ideas upon the peculiarities of the circulation within the cranium; upon the effects of alternations of vascular pressure within that cavity on the functions of the brain; and upon the proximate cause of apoplexy and other comatose affections.

In the four remaining sections numerous facts are adduced which show how far the affections of one important organ may, and often do, depend upon disease going on, perhaps insidiously and unsuspected, in another. This result is more likely to be observed when striking symptoms arise from great disturbance in the circulation of any particular organ, and at the same time an intelligible and close connexion or relation through the blood-vessels can be shown to exist between that and some other organ. It is then readily understood how structural changes in the one will first produce disturbed functions, and ultimately lesions of structure, in the other; for as the blood is constantly moving in a circle, so does obstruction to its course at one point soon involve stagnation, or other irregularity, in different parts of its circuit, and soonest in those parts which are most directly connected through the blood-vessels.

The illustration of this pathological principle is exhibited in the last four sections by establishing the frequent connexion between affections of the brain and structural diseases of the heart. Through the improved physiology of the nervous centres, the pathology of those important organs has been much simplified of late years; and by the employment of auscultation in the investigation of diseases of the heart, their diagnosis has been rendered accurate, and their treatment improved to a surprising extent.

In directing attention to the much more frequent coexistence of structural lesions of the heart in affections of the brain and nervous system than is commonly known, and in more correctly estimating the influence of modifications in the circulation within the cranium on the brain, it may be fairly anticipated that still further advances will be made in the pathology and treatment of affections of this latter organ.

The nature of the inquiry into the above-mentioned topics has compelled a frequent allusion to, and a free commentary on, the opinions of many modern writers; but in doing so the author has been influenced by no ignoble wish to raise himself a reputation at the expense of others; where he has been compelled to differ, he has endeavoured to do so respectfully. This apology applies more especially to the dissent expressed in the early sections from some of the pathological opinions entertained by a late distinguished physician, Dr. Abercrombie, whose various and valuable contributions to medical literature, and whose high professional character, will cause his memory to be venerated, not only by his contemporaries, but by all succeeding generations of British physicians.

Some new matter, and a few cases bearing upon the pathological doctrines maintained in the different sections, have been introduced; the observations on the treatment of apoplexy and hemiplegia*, as well as those upon the treatment of acute affections of the heart accompanied with symptoms of nervous irritation*, have been extended considerably beyond their original limits in the lectures delivered before the College of Physicians. The author has hoped to render the work of more practical value than it would otherwise have possessed without such applications of principles to treatment. On the other hand, he has been unwilling to introduce a long array of cases of apoplexy and hemiplegia, the particulars of which would not differ from those recorded by many preceding writers in any other important point than in the uniform attention which was paid to the state of the heart.

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* Section V.

Some explanation may be expected to account for the diversity of style in which the different sections are composed. This has resulted from a great part of the work having been originally delivered and published in the form of lectures, while the remainder has been written with more deliberation. Unless the whole of the original matter had been recomposed, this imperfection could not have been avoided; the advantages to be obtained by such a labour would hardly have counterbalanced the loss of time employed upon it.

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* Section VII.

Every precaution has been taken in the preparation of the coloured engravings with which the work is illustrated, to ensure a faithful representation of the degree of vascularity exhibited to view in the original experiments.

45, Queen Anne Street, Cavendish Square,
May 1846.

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ON

DISORDERS

OF THE

CEREBRAL CIRCULATION.

SECTION I.

ON THE PECULIARITIES OF THE CIRCULATION IN THE BRAIN.

THE pathology of the brain and spinal cord has of late years derived great and valuable elucidation from the improved physiology of these nervous centres. The functions of particular parts of the cerebro-spinal system have been clearly pointed out by a succession of experimentalists following in the path which was first so successfully trodden by our distinguished countryman, the late Sir Charles Bell. But the simplification of the pathology of many complex affections of these organs, which, although bearing considerable resemblance in their symptoms, are in essence very different—"facies non omnibus una, nec diversa tamen"—has, I believe, been effected principally by the researches of Dr. Marshall Hall. While great progress has been made in the diagnosis of nervous affections, particularly in reference to the real source of irritation to the nervous centres, it appears to me that there has not been a corresponding advance in our pathology of affections of the brain depending on the state of the circulation in that organ.

If the influence of the nervous centres upon the circulation, upon the force and frequency of the heart's contractions, be a well-established fact in physiology, it is no less incontestible that the functions of these same nervous masses are greatly dependent upon the circulation of blood through them. In order that the brain should perform its functions freely and vigorously, it is above all things necessary that it should receive a sufficient supply of arterial blood, and that no obstacle should impede the return of venous blood from the cranium.

Impressed with a conviction that some erroneous opinions, in reference to the circulation within the cranium, are very generally entertained, and that these errors obstruct our advances in the pathology of a most important organ, I shall endeavour in this section to establish more correct principles on this part of the physiology of the brain, and shall, in the succeeding sections, apply those principles to the elucidation of several serious cerebral affections.

I therefore propose to inquire, in the first place; what modifications the circulation in the brain is capable of undergoing in health and disease: secondly, how far the central organ of the circulation, the heart, when its circulating powers are increased or diminished, is capable of disturbing the functions of the brain, and in what manner these changes in the circulation affect the brain.

Many physicians of high attainments have directed their attention to the peculiarities of the circulation within the cranium; and they, from experiments, and reasonings founded on the mechanical construction of the cranium, have arrived at the conclusion, that the absolute quantity of blood within the cranium is at all times nearly the same.

Morbid anatomists, in apparent opposition to this conclusion, are in the habit of describing congestions of the blood-vessels of the brain, states of hyperæmia of that organ, and so on; while practical men are continually speaking of determination of blood to the head, of plethora of the cerebral vessels; and assuming that such states actually exist, they employ various remedies to diminish these supposed conditions of repletion.

It will, I think, be not without interest and instruction, if we more closely investigate on what grounds the brain has been supposed to be exempted from those variations in the quantity of blood in its vessels, which are generally admitted to be such frequent pathological conditions of the vascular system in other organs.

This doctrine of the invariable quantity of blood within the cranium, was first asserted, as far as I can ascertain, by Dr. Alexander Monro, at Edinburgh. He observes,* "as the substance of the brain, like that of the other solids of our body, is nearly incompressible, the quantity of blood within the head must be the same at all times, whether in health or disease, in life or after death, those cases only excepted in which water or other matter is effused or secreted from the blood-vessels; for in these cases, a quantity of blood, equal in bulk to the effused matter, will be pressed out of the cranium. Monro used to illustrate this doctrine by exhibiting a glass-globe, filled with water, and desiring his pupils to remark that not a drop of the fluid escaped when its aperture was inverted.

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* Observations, &c. on Nervous System. Alexander Monro, M.D. 1783.

In an appendix to Dr. Abercrombie's admirable work, entitled "Pathological and Practical Researches on Diseases of the Brain and Spinal Cord," he has given, under the modest title of "Conjectures in regard to the Circulation in the Brain," some most interesting and novel views on this point of physiology. Dr. Abercrombie's opinions are primarily founded on the appearances of the brain in animals which have been bled to death: he remarks, "While in such animals all the other organs have been completely drained of blood, the brain has in general presented, in this respect, its usual appearance, and in some cases the superficial cerebral veins have even been found distended." When similar experiments were repeated on other animals after a small opening had been made in the cranium by the trephine, the brain was found, on the contrary, as much drained of blood as any other part of the body.

Dr. Abercrombie quotes as his authority for these unexpected conditions of the brain, some experiments of Dr. Kellie,* and states that these phenomena may be explained by reference to the peculiarities in the structure of the head. "The cranium," he observes,† "is a complete sphere of bone, which is exactly filled by its contents, the brain, and by which the brain is closely shut up from atmospheric pressure, and from all influence from without, except what is communicated through the blood-vessels which enter it. In an organ so situated, it is probable that the quantity of blood circulating in its vessels cannot be materially increased, except something give way to make room for the additional quantity, because the cavity is already completely full; and it is probable that the quantity cannot be materially diminished, except something entered to supply the space which would become vacant. Upon the whole, then, I think we may assume the position as being in the highest degree probable, that, in the ordinary state of the parts, no material change can take place in the absolute quantity of blood circulating in the vessels of the brain."

The accuracy of the experiments of Dr. Kellie, and his inferences from them, have not only been adopted by Dr. Abercrombie, and supported by arguments founded on the immutable laws of physics, but they have also been sanctioned by some of the first medical authorities of the present day.

Many public lecturers have promulgated the opinion that the brain is the only organ which, under the ordinary state of the parts, contains at all times the same quantity, or very nearly the same quantity, of blood. "This depends," remarks Dr. Watson, "upon the mechanical construction of the cranium, and is capable of explanation upon the known principles of hydraulics." "This conclusion, which would be arrived at by *à priori* reasoning, is confirmed by certain very curious experiments performed by Dr. Kellie, from which we learn that, in animals bled to death, the brain presented its ordinary appearance, or even seemed to contain more blood in its superficial vessels than usual; and in one instance the sinuses were loaded with dark blood, and the pia mater injected with florid blood." *

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* Medico-Chirurgical Transactions of Edinburgh, vol. i. p. 2.

† Op. cit. p. 302.

Other modern writers on the pathology of the brain have carried these theories of Dr. Kellie and Dr. Abercrombie still further. Thus we find it stated by Dr. Clutterbuck,† "that no additional quantity of blood can be admitted into the vessels situated in the brain, the cavity of the skull being already completely filled by its contents. A plethoric state, or overfulness of the cerebral vessels altogether, though often talked of, can have no real existence; nor, on the

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[*] Lectures on Medicine, MEDICAL GAZETTE, Vol. 27. I have the satisfaction of finding that the whole of this interesting subject has been carefully reconsidered by Dr. Watson, who handsomely admits that the experiments and arguments brought forward in this section "have most convincingly shown that the conclusions of Dr. Kellie and others were erroneous. The theory which is thus demolished," continues Dr. Watson, "involved probably more than one erroneous assumption. By this refutation of a prevalent error, not unlikely to warp or mislead our practice in some cerebral disorders, the science of medicine has derived an essential service." (Lectures on the Practice of Physic, vol. i. p. 351-3. 2d edition).

[†] Article on Cerebral Apoplexy, in the Cyclopædia of Practical Medicine.

other hand, can the quantity of blood within the vessels of the brain be diminished. No abstraction of blood, therefore, whether it be from the arm or other part of the general system, or from the jugular veins (and still less from the temporal arteries), can have any effect on the blood-vessels of the brain, so as to lessen the absolute quantity of blood contained within them."

Thus Dr. Clutterbuck not merely adopts the opinion of Dr. Abercrombie, that in the ordinary state of the parts no material change can take place in the quantity of blood in the vessels of the brain, but he maintains that no abstraction of blood can lessen the quantity of blood in them.

Dr. Kellie's experiments (as quoted by Dr. Abercrombie) are cited by Dr. Clutterbuck in support of his opinions. Even foreign writers have been influenced by the opinions of Dr. Abercrombie; and thus Rochoux, although he describes an intense state of congestion of the blood-vessels of the head, both external and internal, in cases of apoplexy which terminate fatally within forty-eight hours from the seizure, makes the following remarks*:—"Although the brain receives an enormous quantity of blood, still its circulation is carried on in such a way, that the quantity of blood within it is constantly the same, or nearly so. This important point of physiology has been placed beyond a doubt by the interesting experiments made upon sheep by Monro and Kellie, as well as by their observations on the brains of those who have died by hanging."

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* Rochoux, Recherches sur l'Apoplexie, p. 311. Paris, 1833.

Such, then, are the physiological doctrines with respect to the peculiarities of the circulation in the cranium, which have been promulgated by many distinguished writers and teachers of the present day. One and all appear to refer to the experiments of Dr. Kellie, and to the mechanical structure of the cranium, in support of this theory of the invariable quantity of blood in the vessels of the cranium. It becomes, then, a point of primary importance, in commencing the reconsideration of this subject, to examine with care the often-quoted experiments of Dr. Kellie. I shall therefore proceed to give a concise account of them. I am more strongly induced to give an abstract of these experiments, because I suspect that most writers on this subject, subsequent to Dr. Abercrombie's publication, have been satisfied with his allusions to the experiments of Dr. Kellie, and that few have taken the trouble to analyse the original account of them. As I proceed with this abstract, I shall detail analogous experiments performed by myself. The physiological conclusions deduced from them will contrast very forcibly with the opinions on this peculiarity of the cerebral circulation which have been maintained by Dr. Abercrombie, Dr. Kellie, and other modern British authors.

Dr. Kellie inferred from his experiments—

1. That a state of bloodlessness is not discovered in the brains of animals which have died by hæmorrhage;

but, on the contrary, very commonly a state of venous cerebral congestion.

2. That the quantity of blood in the cerebral vessels is not affected by gravitation, or posture of the head.

3. That congestion of the cerebral vessels is not found in those instances where it might be most expected; as in persons who die by hanging, strangulation, suffocation, &c.

4. That if there be repletion or depletion of one set of vessels (arteries or veins) in the cranium, there will be an opposite condition of the other set of vessels.

I shall proceed to detail a few of the experiments performed by Dr. Kellie, and by which he supports his first proposition, that, when death takes place by hæmorrhage, it has not the effect of depleting the cerebral vessels; but, on the contrary, that in such cases the cerebral veins contain as much, or even more, blood than is usual.

Dr. Kellie has employed an alphabetical notation in the arrangement of his experiments. We will take the experiment E.

"In this experiment both carotids of a sheep were tied, and four minutes after the jugular veins opened. The quantity of blood lost was thirty-eight ounces, when the animal died. The heart contained no appreciable quantity of blood. The sinuses of the brain were in their usual state; those at the basis contained less blood than had been found in similar experiments, and the veins on the hemispheres were less filled; the choroid plexus was pale and empty: the vessels on the basis of the cerebrum were better filled, and those on the basis cerebelli minutely injected."

Exp. H.—"A dog was bled to death from the carotids, having lost thirty-seven ounces of blood. The viscera in general were well drained of their blood. The dura mater contained little blood: the lateral sinuses were, however, well filled. On the pia mater were several vessels of a florid colour, but not turgid. This brain seemed upon the whole more depleted than usual."

Now it will be interesting to contrast the appearances of the vascular system of the brain in the two foregoing experiments, where the animals died by hæmorrhage, with the condition of the brain in two other animals, where death was caused by other means.

Exp. L.—Both carotids and both jugulars were tied in a dog, an operation which it survived twelve hours. The vessels of the dura mater were remarkably turgid, and all the sinuses much loaded with blood. Both the larger and the smaller vessels of the pia mater were fully injected with red blood. Not only the pia mater through its whole extent, but the cineritious substance, had a suffused, reddened, and, as it were, blood-shot appearance. "In short," writes Dr. K., "this brain was gorged with blood in all its minuter vessels," and was obviously in a very different state of vascularity to those of animals bled to death in the experiments E and H.

Let us analyse another experiment (M). In this a dog was poisoned with prussic acid. "The sinuses and veins were found loaded and congested, and the brain was every where turgid with blood. It was quite evident," writes Dr. Kellie, "that this brain, and that of the dog (L), contained, beyond all doubt or dispute, a much larger quantity of red blood than the brains of any of the animals which had been bled to death. These comparative experiments afforded us the most satisfactory proof that the other brains had been really depleted by bleeding, and their vessels drained of a very sensible proportion of the red blood usually contained by them."*

The summary of these observations is thus stated: that though we cannot entirely or nearly empty the vessels of the brain, as we can the vessels of the other parts of the body, it is yet possible, by profuse hæmorrhage, to drain it of a sensible portion of its red blood. If, instead of bleeding *usque ad mortem*, we were to bleed animals more sparingly but repeatedly, there is no doubt that we should succeed in draining the brain of a much larger quantity of red blood, although serous effusion would be increased.

It may, then, appear surprising that Dr. Kellie has been so often quoted as asserting the brain cannot be depleted by blood-letting, when we find him stating that his experiments satisfactorily proved that these brains had really been depleted by bleeding, and their vessels drained of a very sensible proportion of the blood usually contained in them. But in opposition to the conclusions drawn from these experiments, we find, in a subsequent communication to the Medico-

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* Page 115, op. cit.

Chirurgical Society of Edinburgh, Dr. Kellie affirming* "that, in the ordinary state of the parts, we cannot lessen, to any considerable extent, the quantity of blood within the cranium by arteriotomy or venesection;" whereas, if the skull of an animal be trephined, then hæmorrhage will leave very little blood in the brain.

This apparent contradiction between the results of experiments and subsequent statements induced me to repeat the experiment of bleeding animals to death, and to compare the state of the cerebral blood-vessels in them and in animals which had died from other causes.

Could I have found any series of experiments, performed by others, which corroborated or invalidated the opinions of Drs. Abercrombie and Kellie, I should have refrained from the needless repetition of them on living animals. I have, however, up to the present time, fruitlessly searched for any additional information on this interesting point in physiology, a point which has such direct bearings on practical medicine. I had anticipated finding in Dr. Marshall Hall's work "On the Effects of Loss of Blood," the desired information; but it does not appear that, at the time of the publication of that volume, the author had made any examination into the state of the blood-vessels of the brain after hæmorrhage; for he remarks "that we are altogether in want of a series of observations on the effects of loss of blood on the internal organs." Thus disappointed in my search for information on this subject, I determined to resort to fresh experiments.

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* Medico-Chirurgical Transactions of Edinburgh, vol. i.

On the 11th of January, 1843, I killed two well-grown rabbits. The one (A, Plate 1) by opening the jugular vein and carotid artery on one side of the throat; the other (B, Plate 2) was strangled. Each animal died violently convulsed. A ligature was drawn tightly round the throat of the rabbit (A) immediately it expired, to prevent any further escape of blood from the vessels of the head. The rabbits were allowed to remain twenty-four hours on a table, resting on their sides.

While the blood was flowing from the rabbit (A), the conjunctiva was observed to become pallid, and the eyeballs to shrink within the sockets. Upon the examination of the head of this rabbit, the integuments and muscles appeared blanched and exsanguined. Upon removing the upper portions of the cranium, the membranes of the brain were found pallid, and scarcely the trace of a blood-vessel was to be detected on the surface of the brain. The longitudinal and lateral sinuses were nearly empty of blood, and their course was not denoted by any colour of blood. Upon making sections of the brain, the interior appeared equally exsanguined.

Soon after the cord was drawn tight round the throat of the rabbit (B), the conjunctival vessels became congested, the eyeballs turgid, prominent, and even projecting beyond the margin of their sockets. The integuments and muscles of the head were found full of blood. Upon opening the cranium, the superficial vessels of the membranes, as well as the sinuses, were full of dark liquid blood. The whole substance of this brain, and its membranes, appeared of a dark reddish hue, as if stained by extravasated blood. The contrast between the two brains in point of vascularity, both on the surface and the interior, was most striking.* In the one scarcely the trace of a blood-vessel was to be seen; in the other every vessel was turgid with blood.

It seems hardly necessary to bring forward further evidence to prove that death by hæmorrhage has a most decided effect in depleting the vessels, and reducing the quantity of blood within as well as upon the outside of the cranium. However, I have repeated the experiments with similar results.† In fairness to Dr. Kellie I should state, that I have attended at the slaughtering of sheep by butchers, and find the brains of those animals much less depleted than the brains of rabbits which have died by hæmorrhage. But these sheep did not die from simple loss of blood; but partly from division of the pneumogastric nerves and cervical portion of the spinal cord. These lesions, no doubt, influenced the appearances.

A valuable document, recently published‡ by Dr. Webster, throws much additional light on the relative states of congestion of the cerebral vessels in a large number of patients suffering from affections of the brain, and on the effects of hæmorrhage on the cerebral vessels. The document I refer to is a tabular synopsis of the principal pathological appearances met with in 72 insane patients examined at Bethlem Hospital by Mr. Lawrence, the distinguished anatomist and surgeon to that institution.

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* Coloured drawings of the brains of these animals were exhibited in the Lecture-room of the College of Physicians. (Vide Plates 1 and 2).

† The craniums of these rabbits opened were exhibited for inspection.

‡ Medico-Chirurgical Transactions, vol. xxvi.

In 53 out of the 72 cases examined, the vessels of the brain were found congested; sometimes they were turgid; at other times extremely turgid; and, upon one occasion, Mr. Lawrence reported that he had never seen the blood-vessels of the brain and its membranes more injected with blood. Among the whole number the cerebral vessels were found exsanguined—" unusually empty"—only once, and in this case death was caused by hæmorrhage from the bursting of a femoral aneurism three days prior to the fatal event. When we learn that in the autopsies of 72 insane patients the cerebral vessels were found unusually empty only once, and that this patient bled to death from the bursting of an aneurism, can we give credence to the statement, that the quantity of blood in the cerebral vessels is always nearly the same? or that artificial abstraction of blood does not diminish the actual quantity in the cerebral vessels?

Hence it is not a fallacy, as some suppose, to assert that bleeding diminishes the actual quantity of blood in the cerebral vessels. By abstraction of blood we not only diminish the momentum of blood in the cerebral arteries, and the quantity supplied to the brain in a given time, but we actually diminish the quantity of blood in those vessels. Whether the vacated space is replaced by serum, or resiliency of the cerebral substance under diminished pressure, is another question, into which I do not now enter.

2dly.—Dr. Kellie, assuming the cranium to be a perfect sphere, proceeds to show that the quantity of blood in the cerebral vessels is not affected by posture.

"I think," writes Dr. K., "it quite certain, at least in a previously sound and healthy condition of the brain and its vessels, no change of posture can impel into, or confine more or less blood within, those vessels than naturally belongs to them; though I am willing to allow that the general pressure of the circulating fluid may in this way be, under certain circumstances, increased or diminished, and the circulation through the head accelerated, retarded, or disturbed."

In order to ascertain, as far as such an experiment can do, the total effect of the gravitation of the blood upon the vessels of the brain, Dr. K., immediately after administering a destructive dose of prussic acid to two dogs, suspended the one by the heels, and the other by the ears. He allowed them to remain thus suspended for eighteen hours, when they were taken down for examination.

The effects of posture on the parts exterior to the skull Dr. K. reports to be very great. In the former animal the integuments and their vessels were filled and congested to the greatest possible degree; the integuments of the head of the second dog were pale, and the vessels empty. "Within the head," continues Dr. K., "the contrast was but trifling. The sinuses beyond all doubt were loaded in the first case, and rather empty in the other; the difference of appearance in other parts of the brain was but little striking." Dr. Kellie's own words, as to the condition of the sinuses in the two animals, assured me that posture had a much greater effect on vascular congestion of the brain than he was willing to admit. I therefore repeated his experiment.

On the 28th of December, 1842, two full-grown rabbits were killed by prussic acid, and, while their hearts were still pulsating, the one (C, Plate 3,) was suspended by the ears, the other (D, Plate 4,) by the hind legs. They were left suspended for twenty-four hours; and, before they were taken down for examination, a tight ligature was placed round the throat of each rabbit, to prevent, as effectually as was possible, any further flow of blood to or from the head, after they were removed from their respective positions.

In the rabbit (C) the whole of the external parts of the head, the ears, the eyeballs, &c. were pallid and flaccid; the muscles of the scalp and bones of the cranium were also remarkably exsanguined. Upon opening the cranium, the membranes and substance of the brain were pallid, the sinuses and other vessels were exsanguined; anæmic beyond my expectation.

In the rabbit (D) the external parts of the head, the ears, eyeballs, &c. were turgid, livid, and congested. The muscles and bones of the cranium were of a dark hue, and gorged with blood, which at some parts appeared extravasated. Upon opening the cranium, the membranes and vessels were dark and turgid with liquid blood; the superficial veins were prominent, the longitudinal and lateral sinuses were gorged with dark blood, and there was staining of the tissues, if not extravasation of blood into the membranes. The substance of the brain was uniformly dark, and congested to a remarkable extent.

Dr. Kellie asserts, but I think his experiments do not support him, that the contrast in the appearances within the heads of the two animals was but trifling. In my analogous experiments the contrast was most striking. In the one was to be seen a most complete state of anæmia of the internal as well as external parts of the cranium; in the other a most intense hyperæmia or congestion of the same parts; and these opposite conditions in the vascularity of the brain induced solely by posture, and the consequent gravitation of the blood.*

If the cranium were the perfect sphere, as taught by Monro, and as subsequently maintained by Abercrombie and other distinguished writers on the pathology of the brain, these effects on its circulation (which I have now described) ought not to have resulted from the force of gravity on the blood in the cerebral vessels.

From the foregoing experiments it would appear, that the principle of the subsidence of fluids after death operates on the parts contained within the cranium, as well as upon those situated in the thorax or abdomen.

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* Coloured drawings of the brains of these animals (Plates 3 and 4) were exhibited in the Lecture-room, as well as the craniums of two other animals killed in the same way, and then laid open for comparison. The effects of posture on the quantity of blood in the cerebral vessels were also exhibited by drawings made from the brains of animals killed by placing a ligature around the trachea, and then suspending the one animal by the ears, but leaving the other resting on its side (Plates 5 and 6).

It is well known that, in former times, the stains, or *sugillations* as they are technically termed, which are discovered on the integuments of the under parts of a corpse, were not unfrequently mistaken for the effects of violence done to the body during life. Within a more recent period the cadaveric congestions of the posterior part of the lungs, and of depending convolutions of the intestines, have been mistaken for the effects of inflammation. M. Orfila and M. Trousseau have done much to dissipate those pathological errors. In the article "Pseudo-morbid appearances," (Cyclopædia of Practical Medicine), I find Dr. Todd gives a caution, that, in estimating the colour of the cerebral substance, allowance must be made for the quantity of fluid blood in that viscus, as well as for the position in which the head of the corpse has been laid since death. I hence infer that this able anatomist coincides in the opinion that the quantity of blood in the brain varies during life, and is affected by posture after death. The most remarkable instance of intense cerebral congestion which ever fell under my observation, occurred under circumstances highly favourable to the gravitation of the blood to the vessels of the head.

A middle-aged gentleman offered his life for insurance in one of the London Offices. He informed the medical officers of the Insurance Company that he had been liable to headaches, but had otherwise enjoyed good health. The risk was accepted for a considerable sum. Within two months after effecting this insurance he went down into Essex for the purpose of angling, of which amusement he was very fond. Upon one occasion, having gone out after an early dinner, and not returning at his usual hour, search was made after him, and he was found partly immersed in the fish-pond; his head was in the water, with the face downwards; his feet resting on the bank, and his fishing-rod close beside him. There was some suspicion of suicide. I was requested, in conjunction with the surgeon of the Insurance Company, to attend the inquest on the body, to make a careful examination of the corpse, and thence to form an opinion as to the real cause of death. We could find no trace of disease, but excessive congestion of the blood-vessels of the membranes and substance of the brain: the vessels ramifying in the diploe of the skull-cap were enormously dilated, and very numerous. In this case the headaches had probably depended upon repeated attacks of cerebral congestion; and this individual's death may have been occasioned by sudden vertigo, which caused him to fall forwards into the water. The distension of the cerebral blood-vessels must have been greatly augmented by the mode of death (submersion), and by the depending posture of the head after death. The appearances discovered within the cranium of this gentleman support the fidelity of the experiments already described, and particularly those wherein cerebral congestion was induced either by apnœa or gravitation (Plates 2, 4.)

It may now be affirmed that the encephalon is not exempt from this law in physics—the gravitation of the fluids to the lowest parts of the corpse.

The discovery of the operation of this force on the blood within the cranium after death, suggests a precaution very essential to be followed, when it is desired to ascertain the precise amount of congestion of the cerebral vessels at the time of death. In such cases a ligature should be placed around the throat of the corpse, and drawn sufficiently tight to compress the cervical vessels, and arrest all flow of blood through them. This precaution will be most required in the examination of bodies, where, from the kind of death, the blood may be suspected to remain fluid in the heart and great blood-vessels. The depending or elevated position of the head during the examination of the body will not then induce deceptive appearances, which mislead us in our conclusions as to the previous amount of congestion in the cerebral vessels.

3dly. Dr. Kellie's argument against the occasional repletion of the vessels within the cranium is also founded on the reported condition of these vessels in those kinds of death where cerebral congestion might have been fairly anticipated, as in death by hanging, suffocation, drowning, and so on; or in death by asphyxia, as it was formerly termed, but more correctly by apnœa. In support of his position, that cerebral congestion is not discovered when death takes place by asphyxia or apnœa, Dr. Kellie adduces an account of the appearances in the bodies of two pirates, who were hung at Leith, and dissected by Monro and himself. The bodies were examined while yet warm; the limbs were not rigid; the countenances livid, and the eyeballs suffused. In each body, on the division of the scalp, blood flowed from its vessels in such quantity, as to afford ample proof of congestion of the external parts of the head. The sinuses of the dura mater contained no extraordinary quantity of blood; the large vessels on the surface of the brain were but moderately filled; the pia mater was paler and less vascular than it is found in ordinary cases. No sooner was the brain removed from the skull, than the blood, yet warm, began to rise, and flow profusely from the divided sinuses and vessels at the base of the skull: about one pint of fluid blood thus escaped, and coagulated on the floor.

That the brain and its membranes are not necessarily congested in the bodies of those who have died by hanging, is corroborated by the detail of the condition of these parts in the body of Bishop, the resurrection-man, who was hung for the murder of Carlo Ferrier, in November 1832. Dr. Watson states,* that the integuments of the head and face were turgid with blood; the inner surface of the scalp and outer surface of the skull red and bloody; very dark-coloured blood ran from the divided integuments; but when the bones of the head were sawn through, and the skull-cap removed, the large veins of the brain did not appear unnaturally full.

One more instance, equally worthy of credit, may be cited in proof of this condition of the vessels of the brain of those who have died by hanging. M. Esquirol gives the following account of these parts in the body of a woman who hung herself, and was found suspended six hours after death. The face was livid and bloated; the scalp was loaded with fluid blood, while the membranes of the brain were slightly vascular, and the brain itself natural.

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* Lectures on Medicine, MEDICAL GAZETTE, vol. xxvii.

The appearances in the brains of these persons who died by hanging would appear to support the opinion that the cerebral vessels are not congested or overloaded in those cases where such a condition might be fairly expected. But, in opposition to such a conclusion, it would not be difficult to cite numerous well-authenticated instances of death by hanging, where the brain and its membranes have presented all the usual appearances of congestion, and even of apoplexy, to a striking extent. In the late Dr. Cooke's learned work on Nervous Diseases (which was the substance of his Croonian Lectures, delivered at the College of Physicians in 1819), there will be found some remarkable examples of this kind. Sir B. C. Brodie informed Dr. Cooke, that he found congestion and extravasation of blood to a large amount in the brain of a man who had been hanged. The late Dr. Hooper had in his collection the brain of a person who died by hanging, and which exhibited the effusion of a great deal of blood into the membranes. M. Portal reports that, upon the examination of the bodies of persons who had been hanged, and which were brought to him for anatomical purposes, a large quantity of blood was found in the vessels of the brain, or extravasated into that viscus.

But I would fain relate the pathological appearances in one other case of death by suspension; because, from the rank of the individual, and the peculiar circumstances under which he died, the examination of the body was made with the most scrupulous attention by several scientific men, well qualified for their task.

In the autumn of 1830, a few months after the French Revolution, the Duke de Bourbon, the last of the Condés, was found dead in his bed-chamber, suspended by a couple of cravats to the fastening of his window shutter. His toes were slightly resting on the floor, which posture of the body, together with the advanced age of the Prince, his known infirmities, and certain political reasons, led to the suspicion that he had been murdered, and afterwards suspended, to give the appearance of suicide. His body was carefully examined by MM. Marc, Marjolin, Pasquier, and others. They reported* that the vessels on the surface of the brain, especially on the anterior lobes, were gorged with dark *fluid* blood. Three ounces of serum were found in the ventricles and membranes of the brain. The lungs were also gorged with black *fluid* blood. The cavities of the heart devoid of blood. It was their opinion that the Duke had destroyed himself by hanging, and that death was induced by the *accumulation* and stagnation of blood *in the brain* and lungs.

But let it not be supposed that I have adduced these examples of cerebral congestion and cerebral hæmorrhage, in individuals who have died by hanging, in support of the theory that in this kind of death life is destroyed by apoplexy. It is well ascertained that obstruction to respiration is the principal cause of death in such cases. I have described these examples of intense cerebral congestion, where death was caused by hanging, to contrast with those other instances which have been cited as proofs that cerebral congestion is not found after this mode of death.

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* Annales d'Hygiène, vol. v.

That an intense congestion of the cerebral vessels is discovered after death produced by various kinds of obstruction to respiration, is also manifest from the experiments and drawings which I adduced by way of illustration.*

But how are we to account for the undoubted occasional absence of this congestion of the cerebral vessels in those who have died by hanging?

When criminals are hung by the executioner, the knot of the rope is usually adjusted on one side of the neck; and it is found, after death, beneath the ear, resting on the mastoid process. It has been often observed, in the dissection of such criminals, that the cheek and integuments on this same side of the head are not near so livid and congested as on the other side. The pressure of the rope has not completely obstructed the return of blood through the external jugular vein on the one side, although it has effectually stopped the current on the other. In such cases it is probable that the deep-seated internal jugular vein on the one side has only been partially compressed, and has permitted to a certain extent the return of blood from the internal parts of the cranium.

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* Drawings to illustrate—Death by strangulation: death by ligature on the trachea (Plates 2, 5, and 6).

But there is another still more efficient cause of this occasional absence of congestion of the cerebral vessels after death by hanging; it is the subsidence of the *fluid* blood after death, while the body is yet suspended, through the cervical vessels which are not completely obliterated by the pressure of the cord. And it should be recollected, there are some channels which are scarcely if at all affected by the compression of the rope. These other channels are the vertebral sinuses, and spinal plexus of veins, so ably delineated by M. Breschet. Well may we adopt the language of Haller, in describing this complex contrivance to carry off the blood from the nervous centres:—"Magna pulchritudo est sinuum, qui duræ matri medullæ spinalis adcumbunt, venæque, potius sunt, quam sinus;" and after describing the circular distribution of these vessels, and their free communication with the cervical, intercostal, lumbar, and sacral veins, he says, "Eorum annulorum supremus cranioque proximus, cum sinubus occipitalibus et cum fossis jugularibus unitur." From this description we learn that the sinuses of the cranium may be drained through these vertebral sinuses.

Having already shown (Plate 3, C,) to what extent gravitation alone can deplete the cerebral vessels after the heart has ceased to beat, it cannot be a matter of surprise that, in some of those who die by hanging, and whose bodies remain suspended for a considerable length of time after death, the fluid blood should gravitate, and thus the "large cerebral veins should not appear unnaturally full," or even less distended than usual.

But the true state of the cerebral vessels in the bodies of those who have died by hanging, is often incorrectly estimated, from the anxiety to examine the lesions produced by the compression of the rope on the larynx and trachea, as well as the condition of the heart and lungs. In making such examinations all the great vessels of the neck are usually cut across, and the thoracic organs removed from the body, before the head is examined. While the head is elevated during the operation of removing the skull-cap and examining the brain, the *fluid* blood gravitates from the cranium, and pours from the divided cervical vessels into the chest; and then, to the surprise of the by-standers, "the sinuses of the dura-mater, and the larger veins on the surface, are found but moderately filled," or "do not appear unnaturally full."

That these are the causes tending to diminish the congestion of the cerebral vessels, when death takes place by hanging, appears to me probable from the intense congestion of the same vessels discovered in other examples of apnœa, where life is annihilated by obstruction to respiration, and where gravitation has had no effect upon the blood in the cranium.*

The deductions from the foregoing experiments are supported by the authority of Dr. Carpenter, one of the best and most recent writers on asphyxia. He states,[*] that when death is produced by the forcible compression of a ligature round the neck, to such an extent as to impede or prevent respiration, the veins and sinuses of the head partake of the general venous congestion; and in well-marked cases an unusual number of red points are seen on slicing the brain. An apoplectic extravasation is sometimes, though rarely, found in simple asphyxia, but is more frequent in death by hanging or strangulation. "It can scarcely be doubted," continues Dr. Carpenter, "that these variations in the congestion of the brain depend principally on the mode in which the ligature is applied to the neck."

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* These appearances are exhibited in the drawings (Plates 2 and 6,) made from the brains of animals that died by strangulation and suffocation, and which were exposed for inspection.

From a series of experiments detailed in the Annales d'Hygiène,[†] it would appear that the apoplectic condition of the brain is less likely to be found in proportion to the proximity of the ligature to the lower jaw, which is its exact situation in death by hanging.

Enough has been said on this point of the pathology of the brain, to prove that, in the majority of instances, when death takes place by strangling, hanging, suffocation, drowning, and other means of causing apnœa, that a congestion of the cerebral vessels is found after death. The same condition is also found after death from those diseases which obstruct the return of venous blood from the brain. And where such congested state of the cerebral vessels is not marked in cases of death by apnœa, the absence of congestion may often be accounted for from the subsidence of the blood, which is facilitated by its fluidity, and the posture of the body after death.

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[*] Asphyxia: Library of Medicine.

[†] Vol. viii.

Dr. Kellie's fourth proposition is, that if there be repletion or depletion of one set of vessels (arteries or veins) in the cranium, there will be an opposite condition of the other set of vessels.

Those who maintain that the absolute quantity of blood in the cerebral vessels does not vary, admit a disturbance of the cerebral circulation in the following manner:—They point out the probability of a frequent alteration in the relative quantities of blood in the cerebral arteries and veins. Thus, they assert that those pathological states which have a tendency to cause influx of blood into the cerebral arteries, and accumulation in those vessels, will accomplish this change at the expense of the cerebral veins. Again, anything causing obstruction of the return of blood from the cranium will produce fulness of the sinuses and cerebral veins, but, at the same time, the quantity in the arteries will be equally diminished. They also maintain, if the quantity transmitted to the brain be lessened, the cerebral arteries will be comparatively empty; but there will be a corresponding fulness of the venous system within the cranium. These opinions of Drs. Abercrombie and Kellie were adopted by Dr. Watson, who supported them by similar reasonings. In states of anæmia, he informs us,* a diminished quantity of blood will be transmitted towards and into the cerebral arteries; but the whole volume of blood in the brain remains the same; therefore blood will accumulate more in the veins. "It is probably in this way that the appearance of congestion in the superficial veins of the brain is brought about in animals that are bled to death." That such venous congestion does not exist, I venture to affirm from the experiments I have performed, and the results of which have already been detailed.

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* Medical Lectures, op. cit.

Some have gone further, and not only asserted that hæmorrhage causes venous congestion of the brain, but have also maintained the paradox, that animals bled to death die of apoplexy. True, indeed, it is that they die with symptoms analogous to those of apoplexy; and this is no new discovery, for this physiological fact was known to Hippocrates. That great man very concisely and tersely expresses the fact in one of his aphorisms, "Σπασμὸς γίνεται ῆ ὑπο πληρωσεος, ῆ κενωσεος."*

Hippocrates, in this sentence, announced the remarkable pathological truth, that depletion or repletion of the vascular system produces similar symptoms of disturbance of the nervous centres.

Not only have the principles of hydrostatics and other immutable laws of physics been invoked to support the theory that the absolute quantity of blood within the cranium is invariable, or nearly so, but the symbols of algebra have been made to perform their precise evolutions to show that when any increase takes place in the quantity of blood in the arteries of the brain, there must be a corresponding decrease in the veins. If a decrease in the arteries, then an increase in the veins. Thus it is said, if the whole quantity of blood within the cranium = C, a constant, the quantity of blood in the arteries = x, the quantity of blood in the veins = y, then $C = x + y$ always; but let x be diminished by a quantity (a), then y must be increased by this quantity (a), otherwise the original supposition, $C = x + y = (x - a) + (y + a)$ would not be maintained.

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* Sect. vi.

Hence, according to the theory supported by this algebraical equation, if the carotid arteries be divided, and the quantity of blood in the cerebral arteries be thus diminished, the quantity of blood in the cerebral veins will be equally increased. But the results of experiments negative these speculations, and show that a diminution of the quantity of blood in one set of vessels is not necessarily accompanied by a state of repletion of the other system of vessels.

There must, then, be some fallacy in this part of the argument; and the question naturally arises, where is that to be found? I admit, with Dr. Abercrombie and others, the probability of an occasional disturbance in the equilibrium between the quantities of blood in the arterial and venous systems within the cranium, and that such disturbance is productive of many serious cerebral symptoms. But in such cases, I presume, there is also a change in the absolute quantity of blood within the cranium, and not a mere change in the relative quantities in the two systems of vessels.

I believe the error of this part of the argument, which I have been combating, consists in the first supposition, that the quantity of blood in the cranium is a constant quantity. On the contrary, I think that experiments and physiological considerations lead us to the conclusion that the quantity of blood within the cranium is extremely variable at different times, and under different circumstances.

The experiments which support this opinion have been already detailed.*

Those who have maintained this doctrine of the constant quantity of blood within the cranium, have not, I believe, taken into due consideration that large proportion of the contents of the cranium which consists of extra-vascular serum. We know that in health the quantity which exists in the ventricles, membranes, and substance of the brain, is considerable.† Regarding this serum as an important element of the contents of the cranium, I admit that the whole contents of the cranium, that is, the brain, the blood, and this serum together, must be at all times nearly a constant quantity.

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* Some of the physiological phenomena which lead to the same conclusion are well considered by M. Longet, (Anat. et Physiol. du Système Nerveux, pp. 777 and 779). During inspiration, the circulation of blood in the veins, and the return of blood from the head, become more rapid, and at the same time the circulation in the arteries becomes slower. The reverse of these conditions exists during expiration. Hence it follows that during inspiration the brain contains a diminished quantity of blood, because, in a given time, it receives less arterial and loses more venous blood. It follows of necessity that the brain must at one time diminish, and at another increase, either in mass or volume. Longet thinks the experiments of Bourgoguon appear to prove that the surface of the brain does not descend from the level of the bones of the cranium at the time of inspiration. Also, as long as the skull is perfect, no movements of the brain can take place within the cranium. Hence the volume of the brain does not diminish during inspiration : nevertheless, during this period it receives less arterial and loses more venous blood. The consequence is, the mass of the brain must vary. At the time of inspiration there is a rarefaction (diminution of density) of the cerebral substance ; whereas, during expiration, there is a condensation of it ; and this explains why, in spite of the variable quantity of fluids contained in the brain, it always exactly fills the cavity of the cranium. I shall return to this point in the succeeding section, where an explanation differing from M. Longet's will be given.

† From the researches of M. Majendie, it would appear that in the healthy adult the cerebro-spinal serum is never under ii. oz., and often amounts to v. oz. in persons of large frame of body.

But variations in the quantity of serum within the cranium are quite compatible with health; and in morbid states of the brain we know that at one time the cerebral substance, its membranes, and ventricles, will be nearly devoid of serum; while, at another time, these parts abound with serous effusion. In accordance with the variations in the quantity of extra-vascular serum, there must be fluctuations in the quantity of intra-vascular fluid, the blood. From this consideration alone, it seems that the blood may be increased or diminished in the cranium. The increase or decrease may affect the two systems of vessels, arterial and venous, equally, or the equilibrium may be disturbed; there may be excess in either arteries or veins, without any necessary diminution in the quantity of blood contained in the other set of vessels.

It will now be convenient to reconsider how this question stands. It has been said that the brain is enclosed in a complete sphere of bone, the cranium, which removes it from the influence of atmospheric pressure, and hence no material change can take place in the absolute quantity of blood circulating in the vessels of the brain. This proposition is also supported by appeal to experiments and mathematical calculation.

(1). It is maintained, that when hæmorrhage takes place from the general system, it does not affect the quantity of blood in the brain. The experiments I have performed lead me to the opposite conclusion.

(2). Posture of the body after death is said not to affect the quantity of blood within the head. My experiments show that posture has a most striking influence on the quantity of blood in the cerebral vessels.

(3). It has been attempted to prove that when individuals die of asphyxia, or apnœa, there is no excessive congestion of the cerebral vessels. Numerous observations show that in the different kinds of death by apnœa there is great congestion of the cerebral vessels, and that where it is absent it may be accounted for on anatomical and physical principles.

(4). It has also been attempted to prove, by an algebraical equation, that if the quantity of blood be diminished in one system of cerebral vessels, it must be increased in the other vessels. In reply to this, I have shown that the results of experiments negative this conclusion. The error lies in the false assumption of the elements of which the equation is formed. It is also clear that there may be variations in the quantity of blood in one set of cerebral vessels without affecting the condition of the others, because the quantity of extra-vascular serum in the cranium will accommodate itself to the varying states of the blood-vessels.

But how shall we account for these variations in the quantity of blood within the head, if the cranium be a complete sphere, as it has been described by some physiologists?

Does the anatomical structure of the human cranium warrant the opinion that it is a complete sphere, capable of removing its contents from the influence of atmospheric pressure? I think not. The numerous fissures and foramina for the transmission of vessels and nerves through the bones of the cranium appear to me to do away with the idea of the cranium being a perfect sphere, like a glass globe, to which it has been compared by some writers. If there were not always an equilibrium of pressure on the parts within and without the cranium, very serious consequences would arise at the various foramina of the skull. Are, then, the contents of the cranium removed from the influence of atmospheric pressure? I think not, from other considerations. Atmospheric pressure is undoubtedly exerted on the blood in the vessels entering the cranium. This pressure, by a well-ascertained law in hydrostatics, must be transmitted in all directions through the fluid blood, and hence to the blood and other contents within the cranium. If, in the natural state of the parts, the brain is defended from atmospheric pressure, should we not expect to find the functions of that organ disturbed in some way when part of the walls of this sphere is wanting? But in children with open fontanelles, and in adults who have lost part of the bones of the cranium, we observe no peculiar disturbance of the functions of the brain from this gap in the walls of the imaginary sphere. But, lastly, the effects of gravitation on the fluid contents of the cranium, and the effects of the cupping-glass,* which will often draw blood from the vessels of the dura mater, causing ecchymosis there, assures us that the cranium is not a perfect sphere in the sense in which it has been supposed.

Having entered upon the investigation of this part of the pathology of the brain, the evidence bearing upon it would be incomplete, did I not appeal to the experience of those most distinguished for their cultivation of morbid anatomy. We have only to refer to the works, both ancient and modern, of those who have studied the pathology of the brain, and we shall find evidence that the anatomist frequently discovers the vessels of the brain and its membranes "full of blood," "loaded," "turgid," "gorged," "congested"—in a state of hyperæmia.

It will therefore be desirable to make a few brief quotations from some of the highest authorities, to show that they have uniformly described these variable conditions of the cerebral circulation; and that it was not until after the publication of Dr. Kellie's experiments that pathologists hesitated to ascribe to the brain those variations in the state of its blood-vessels which are unanimously acknowledged to exist in every other organ of the body. Morgagni details† the dissections of many persons who died of diseases of the brain, where all its vessels were found greatly congested. He relates one very remarkable case.

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* "If a patient die soon after blood has been abstracted from the scalp by cupping, and the head be immediately opened, all the exterior and interior anastomosing blood-vessels of the scalp and investing cerebral membranes will be found highly injected to a circumference correspondent with that of each glass," (Commentaries on Insanity, p. 594. G. Man. Burrows, M.D.)

† De sedibus et causis morborum.

Pietro Fasolati, æt. 62, an engraver at Padua, retired to bed after eating a hearty supper, and two hours afterwards was found by his wife to be dead. Morgagni examined the body to discover the cause of the death, and could find no extravasation within the cranium beyond a small quantity of limpid serum in the lateral ventricles; but such an unusual quantity of blood distended all the cerebral vessels that he did not remember ever to have seen the like before: even the small vessels, usually imperceptible, were extremely large and turgid. Morgagni, in his remarks upon the case, adverts to the opinions of Galen and many other ancient physicians, that apoplexy was induced by this too great repletion of the arteries, veins, and sinuses of the brain.

Among the numerous dissections of apoplectic patients recorded by M. Portal,* we find that, upon several occasions, he observed cerebral congestion in the highest degree. He was once requested to examine the head of a barrister, who was supposed to have died from serous apoplexy. The dissection, he states, was performed with great care. The vessels of the scalp, the dura mater, and pia mater, were found full of blood. The vessels which ramify between the convolutions, and in the several fissures of the brain, were dilated and swollen with blood. It seemed as if the surface of the brain were covered with an injected network of vessels.

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* Observations sur la Nature d'Apoplexie, p. 5.

The plexus choroides were also gorged with blood; and there was extravasation of that fluid at the base of the brain. The ventricles of the brain were dry; not a drop of serum was found effused there.

Upon another occasion Portal examined the brain of a young man of rank, upon whom he had long been in attendance for epileptic fits, and who at last died apoplectic. In this autopsy the sinuses of the dura mater and veins of the brain were found full of dark blood. The vessels of the brain itself were not only full, but *varicose:* some change of consistence of the substance of the brain and spinal cord was likewise discovered, and an effusion of reddish serum into the ventricles.*

The same writer states he had opened the heads of children who died convulsed and apoplectic during the period of dentition. In some cases the cerebral vessels were gorged with blood; in others there were effusions of blood or serum.

Dr. R. Bright has recorded† several instances of extreme vascular turgescence in the brain met with in fatal cases of bronchitis, emphysema, and pertussis; and he has particularly described the case (CI.) of an elderly man who died of fever, with emphysema of the lungs, where the congestion of the veins of the brain and its investing membranes was most singularly developed. The colour of the surface of this brain was almost as dark as black-lead. He also remarks, when the vessels of the brain become distended beyond the power of contraction, the whole quantity of blood above that which usually circulates in the part is very considerable; and, as there are no means by which a corresponding portion of the usual contents of the skull can be removed, pressure is the inevitable result.

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* Page 190, op. cit.

† Medical Reports, vol. ii.

Modern French medical authors, who are seldom conversant with the writings of their foreign contemporaries, have rarely been influenced by the experiments and statements of Dr. Kellie. They uniformly describe a state of congestion of the cerebral blood-vessels. M. Andral enters very fully into this pathological state of the brain;* and I scarcely know any part of his voluminous and valuable works on Pathology and Clinical Medicine which is more full of interest than his "Resumé" on cerebral congestion. The peculiar opinions of Kellie, Abercrombie, and other British physicians, upon the cerebral circulation, have not escaped the attention of the industrious Germans. In one of the latest and best summaries of the present state of medical opinions in Germany, we find the following remarks†:—

"English physicians have come to the conclusion, that the quantity of blood in the vessels of the brain cannot alter, but remains always the same; and in states of hyperæmia and apoplexy, they only admit a stagnation of the circulation, but not an increase of the quantity of blood there, because, as they assert, there is no room for such an increase on account of the unyielding nature of the walls of the cranium." Dr. Canstadt objects to this conclusion, and remarks that these English writers have not well considered that the substance of the brain is sufficiently elastic and yielding to allow room for the expansion of the vessels by a greater quantity of blood; and he then very accurately describes the appearances of the brain, both when congested and exsanguined.

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* Clin. Med. vol. v. p. 225.

† Pathologie und Therapie von Dr. Carl Canstadt, Band 3, Leifg. 1, p. 31.

It would thus appear that both ancient and modern authors of repute have described a state of congestion of the blood-vessels of the brain; some few, indeed, influenced by the statements of Dr. Kellie, have denied the possibility of excess of blood within the cranium.

If, then, it is proved, as I believe, that the quantity of blood within the cranium, so far from being a constant, or nearly constant quantity, is, on the contrary, as variable as in other parts of the body, the pathology of many serious affections of the brain will require revision.

SECTION II.

ON VASCULAR PRESSURE WITHIN THE CRANIUM, AND ITS INFLUENCE ON THE FUNCTIONS OF THE BRAIN.

The principle of pressure is one of much importance, both in sustaining and destroying the functions of the brain.

The functions of the brain probably cannot be maintained in a healthy state without a certain amount of pressure on the cerebral substance. Any variation of pressure, which we can artificially produce and estimate, appears to affect the functions of this organ. Under the ordinary conditions of health, the cerebral substance is defended by its osseous case from the influence of all variations of external mechanical pressure, and is only subjected to causes of pressure acting within the cranium.

A principal and constant cause of pressure from within, is the momentum of the blood distending the arteries and veins ramifying in the membranes and substance of the brain. But some writers on the pathology of the brain have maintained that this force, as a cause of pressure within the cranium, is inoperative ; — first, because " the cerebral substance is principally composed of inelastic fluids which are incompressible ;" and, secondly, " because the brain is incompressible by any such force as can be conveyed to it from the heart through the carotid and vertebral arteries."*

It will be proper to analyse these objections. In the first, the brain is said to be incompressible, because its substance is principally composed of *inelastic* fluids.

The greatest confusion exists among medical writers on this part of the physiology of the brain, arising from the misapplication and misconception of the terms *incompressible* and *inelastic.* Those properties of bodies which we term incompressibility and elasticity, bear no constant proportion to each other. It is well known that some of the most incompressible bodies are highly elastic, and those which are very compressible are also elastic.

Thus an ivory billiard ball is very incompressible, but highly elastic; Indian rubber is more compressible, and very elastic; and again, a sponge is very compressible, but also highly elastic. Hence there appears to be neither direct nor inverse proportion subsisting between the compressibility and elasticity of bodies.

It should not, therefore, be affirmed, that the incompressibility of the contents of the cranium depends on the inelasticity of the substance of which those contents are composed. In truth, the contents of the cranium, although very incompressible, are highly elastic. As long as medical writers employ the terms of physics and the exact sciences thus loosely, it will be extremely difficult to arrive at the real meaning of experimentalists in physiology.

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* Abercrombie, op. cit.: *chap.* Peculiarities of the Cerebral Circulation.

The second objection advanced against the effects of vascular pressure on the brain is, that the brain is incompressible by any force which can be conveyed to it from the heart through the carotid and vertebral arteries. The consideration of this opinion I approach with some diffidence, because it emanates from no less an authority than Dr. Abercrombie.

The force which is impressed on the cerebral substance through the momentum of the blood in the cranial vessels, is derived partly from the contractile power of the left ventricle of the heart, and partly from the reflux of the venous blood during expiration. These forces have been variously estimated by Hales, Poisseuille, and others. It is not of great importance to the object I have in view, whether the momentum of the blood in the vessels of the head is estimated at a greater or less amount. I wish to establish the truth of the opinion that such a force is constantly operating on the cerebral substance from within; and then to estimate the ordinary effects of this force, and likewise when it is increased or diminished.

All writers on the pathology of the circulation admit the existence of a distending force acting within the arteries at every part of the body. The dilatation of the vessels is chiefly owing to this force. Dr. Parry points out* that as the blood is virtually incompressible, and the vessels being, within certain limits, yielding tubes, their dilatation will be in the direct proportion of the momentum of the blood impelled into them.

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* Elements of Pathology, p. 54.

This dilatation of the vessels must be a cause of outward pressure on the surrounding tissues in all parts of the body ; but there is no organ which will so completely sustain this pressure as the brain. We observe that the tissues of other organs expand and swell in proportion to the momentum of blood in their vessels ; but the substance of the brain cannot expand, because it is confined within the limits of its osseous case. But when a portion of the cranium has been destroyed by accident or disease, or when a piece of the skull has been artificially removed in a living animal, and the dura mater has thus been exposed to view, phenomena are remarked which indicate pressure on the cerebral substance by a force acting from within. It is also observed that this force is not continuous ; its effects vary at different times.

With every systole of the ventricles of the heart the surface of the dura mater rises a little ; the brain appears to swell for a moment, and has a tendency to transgress the level of the bones of the cranium. The surface of the dura mater subsides, and the brain shrinks during the period of their diastole. These movements of the brain were observed at a very early period, and a full account of these phenomena was given by Haller.* That such movements of the brain result from the arterial pulse, or momentum of the blood distending the arteries, may be proved by making pressure upon, and still more decidedly by putting ligatures around, the arteries going to the brain.

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* Elem. Physiol. iv. S. Motus Cerebri Arteriosus.

Thus Chelius observed, in a man suffering from extensive necrosis of the skull, that, when pressure was made on the common carotids, these cerebral movements became weaker, and, by an increased pressure, they were rendered almost imperceptible.

Richerand, Bichat, and more recently Dr. Ecker*, of Stuttgard, having trephined dogs, and observed these pulsating movements of the dura mater, subsequently placed ligatures around the carotids, when a considerable diminution of these movements was remarked. When the vertebral arteries were tied at the same time, these movements ceased, and the animals died. If one of these arteries be opened in a living animal, the pulsating movements of the brain diminish in strength in proportion to the quantity of blood lost, and to the impairment of the heart's energy. Thus, in one of Dr. Kellie's experiments, after he had trephined the cranium of a dog, he observed the alternate rising and subsidence of the dura mater at the opening; but having afterwards divided one of the carotid arteries of the animal, there was an evident gradual sinking of the brain from the level of the cranium, indicating a diminution of the distending force. It has also been remarked, that when syncope occurs, this alternating motion of the brain ceases, and again returns when the heart's action is renewed.

From these observations and experiments, it appears that the brain receives an impulse from the shock of the arterial pulse, which causes a heaving upwards as well as a short quick expansion of its mass; afterwards, at the moment of the ventricular diastole, a collapse of the organ ensues. Also, if the dura mater be exposed to view, and observed during the period of expiration, when the free return of venous blood from the brain is impeded, and a larger quantity of arterial blood is distributed with increased force towards that and other organs, the surface of this membrane is seen to rise; the brain itself swells and becomes turgid, but again subsides with the succeeding inspiration.* All physiologists who have considered this subject agree in regarding these latter respiratory movements of the brain as partly, if not wholly, attributable to the reflux of the blood in the veins during expiration. Ecker, indeed, attributes these movements of the brain in great part to the ascent of the cerebro-spinal fluid during expiration. The last-mentioned writer has detailed† numerous experiments, which show that if ligatures be placed upon the two carotid arteries of an animal, these cerebral movements accompanying respiration are not suspended; but if the external jugular veins in dogs (and these are the principal cerebral veins in these animals) be tied, these respiratory movements are much weakened, but not altogether destroyed: and if the cervical vessels, both arterial and venous, be divided, all movements of the brain are immediately lessened; and when the loss of blood becomes excessive, they cease altogether, and there follows a remarkable shrinking of the organ. But the effects of this reflux of the blood in the veins upon the cerebral substance are still more manifest after those accidents where, with loss of a portion of the bones of the cranium, there is also a laceration of the dura mater. In such cases the distending forces of the vessels acting on the cerebral substance are so strongly exhibited, that not only is the alternate rising and sinking of the exposed surface observed to correspond with each expiration and inspiration, but portions of the substance of the brain are actually protruded through the opening in the dura mater and bones of the cranium. Hernia of the convolutions of the brain is thus effected by a force from within, just as hernia of the convolutions of the intestines is produced by analogous forces, when the walls of the abdomen are accidentally perforated.

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* Physiol. Untersuchungen über die Bewegungen des Gehirns und Rückenmarks, &c. p. 22, von Dr. Alex. Ecker. Stuttgart, 1843.

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* Haller, Elem. Phys. III. S. Refluxus sanguinis venosi, qui a respiratione pendet.

† Op. cit. p. 56-57.

The phenomena above described indicate, that whatever has a tendency to distend the cerebral vessels, whether arterial or venous, exerts a pressure on the substance of the organ; and if the forces distending the cerebral arteries and veins be diminished while these phenomena are under observation, the movements of the brain, and manifestations of pressure from within, are diminished in the same proportion.

The existence of a considerable force within the cranium, arising from vascular distension, and producing outward pressure, must, I think, be conceded. If the walls of the cranium were soft and yielding like those of the abdomen, the cranium would expand, and its capacity be increased in proportion to the increased volume of the brain at each expiration, during which period that organ is the seat of an increased afflux of blood: again, when the brain was diminished in volume during inspiration, the walls of the cranium would follow this subsidence, and its capacity would be proportionately lessened. But as the walls of the skull are rigid and inexpansive, when the brain has this recurring tendency to increase in volume, the walls around oppose the expansion, and sustain this centrifugal, or excentric pressure, which is reflected back upon the substance of the organ.

But Dr. Abercrombie and others have contended that the substance of the brain is not compressible by the force here described. Although I cannot admit that the substance of the brain is altogether incompressible, still I concede to the opinion that it is only slightly so; but, although so little compressible, the substance of the brain must nevertheless feel and sustain the pressure of this force equally as if it were of the most compressible materials. On this part of the subject Dr. Alexander Monro very justly remarked*, "the less compressible we suppose the substance of the brain to be, the more readily we understand how the whole of it may be affected by a plethora, or increased momentum of blood in it."

In conclusion, I believe it to be most important to bear in mind, when considering various pathological states of the brain, that its substance not only contains a variable amount of blood at different times, but that it is also subjected to a constant vascular pressure.

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* Observations on the Nervous System, p. 6.

This pressure arises partly from arterial and partly from venous distension: also it is increased during expiration, and diminished during inspiration: and although the substance of the brain is very unyielding and incompressible, nevertheless it sustains, and is influenced by this vascular pressure. I consider it essential, in studying the physiology or pathology of the brain, to have constantly in remembrance the existence of this vital force. Now vital forces, just as the most efficacious remedies, when they exceed or fall short of their proper amount are capable of producing the most serious ill effects in the animal œconomy. Numerous causes may affect this momentum of the blood in the vessels of the head, and hence give rise to very different degrees of vascular pressure; at one time this vascular pressure may become excessive, oppress the organ and suspend its functions; at another time it is insufficient, and seems to be inadequate to sustain the cerebral functions*. The injurious effects of modifications of this pressure on the brain would be much more often exhibited, were it not for the ample development of the venous system in the cranium and spinal canal, which affords such ready exit for redundant blood; and for another peculiarity in the anatomy of the parts contained within the cranium. The anatomical peculiarity to which I now advert, is rarely pointed out by teachers, and is not sufficiently estimated by pathologists. I allude to the large amount of extra-vascular fluid in the cranium, even in health, and which, in the form of serum, is found in the ventricles and membranes of the brain, as well as disseminated throughout its substance. This fluid, very appropriately designated *cephalo-rachidian,* or *cerebro-spinal,* varies greatly in amount at different times; and, from the anatomy of the parts, as well as from experiments, it would appear that a portion of this fluid readily changes its site from the cranium to the spinal canal, and conversely.

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* The doctrine of pressure here advocated is also maintained by Dr. Watson, who thinks it certain that, whether the cerebral pulp yields to it or not, there is a constant alternation of a greater and a less compressing force exerted upon it during life; and he is also of opinion that Dr. Abercrombie has gone too far, when he says, "we may safely assert that the brain is not compressible by any such force as can be conveyed to it from the heart through the carotid and vertebral arteries." Lectures, vol. i. p. 355. 2d edition.

The presence of a certain quantity of serum in the ventricles and membranes of the brain, as well as within the theca of the spinal cord, is familiar to all conversant with morbid anatomy. That this fluid is also present in the same parts during life appears from the observations of Magendie, Longet, and others*. When the dura mater is exposed and carefully divided in living animals, the subarachnoid tissue over the brain is found to contain a certain quantity of serum; and when the roof of the lateral ventricles in the brains of living dogs was opened by Magendie, he observed a serous fluid there, which had movements corresponding to the respiration of the animals. The same experimentalist removed portions of the vertebræ in living dogs, and found the spinal theca tense. Having punctured the membrane, a certain quantity of serum escaped, when the surface subsided from atmospheric pressure. Anatomy points out that this serum contained within the cranium may readily descend to the spinal canal, and again ascend to the head. The fluid of the lateral ventricles may easily communicate, through the intervention of the third and fourth ventricles, with the spinal canal. The opening from the fourth ventricle to the spinal membranes is narrow under ordinary circumstances, but when the cerebral serous fluid is abundant, this same canal will admit the end of the little finger*. If a coloured fluid be poured into the cerebral ventricles, it will be observed to gravitate into the spinal membranes. It is also remarked, when blood is extravasated into the cerebral ventricles, that the coloured serum makes its way downwards to the spinal cord.

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* Anatom. et Physiol. du Système Nerveux: Longet. Page 196. Paris, 1842.

The foregoing considerations establish the facility of communication between the cerebral ventricles and the spinal membranes. The serum in the arachnoid of the brain makes its way still more easily into the vertebral canal.

Pathological states of the spinal column in children, and experiments upon animals, afford opportunities for observing the changes in the site of this cerebro-spinal fluid under various modifications of pressure. In spina bifida it may be remarked, that the spinal tumor swells and becomes tense during prolonged expiration, as also during fits of coughing and crying. If a graduated pressure be made upon the tumor with one hand, and the fontanelles of the child be examined with the other, in proportion as the spinal swelling decreases in size, so is a swelling of the brain perceived, accompanied by symptoms which usually result from pressure on the brain and spinal cord.

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* Longet: op. cit. p. 196, et seq.

Magendie, Ollivier, and more recently Dr. Ecker, of Stuttgard, have exposed the dura mater and theca of the cord simultaneously in animals, and observed this change of site in the cerebro-spinal fluid from the cranium to the spine, and *vice versâ*. From experiments performed by Ecker*, it appears, when the spinal theca is exposed in a living animal between the occiput and the atlas, there is an alternate rising and sinking of the membrane corresponding with expiration and inspiration. If the theca be carefully divided, the soft spinal arachnoid appears at the opening like a small bladder filled with fluid, in which the above-described movements are still more conspicuous. It would seem that the forces producing these movements in the spinal fluid must be considerable, for Magendie states†, that when the arachnoid of the cord is first punctured in a living animal, the spinal fluid spirts out to the distance of several inches. Magendie attempted unsuccessfully to measure the force of this pressure by Poisseuille's hæmadynamometer. Ecker observed that this fluid continued to flow in a strong stream during each subsequent expiration until a certain quantity had escaped, when further discharge only took place upon forcible expirations.

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* Op. cit. p. 86 ad p. 97.

† Précis de Physiologie, p. 224.

Ecker arrived at the conclusion that this cerebrospinal fluid is in continual motion, engaged in a perpetual alternation of ascent and descent; and this phenomenon he explains as follows :—At the moment of expiration, the vertebral sinuses, which are numerous and ramifying exterior to the theca, are distended with blood. This distension must cause an approximation of the theca towards the spinal cord, and this inward or centripetal movement will create a pressure upon the fluid within the theca. This contained fluid seeks an outlet, which it finds more readily towards the inside of the cranium than elsewhere. The cerebral veins are, indeed, distended at this same period, but the unyielding sinuses within the cranium are not dilated in proportion: the spinal fluid can thus partly escape in this upward direction; it flows in part into the ventricles, and a part probably beneath the arachnoid on the surface of the encephalon. At inspiration the vertebral sinuses empty themselves, the fluid returns to the vertebral canal, and again occupies the vacated space. Ecker is also of opinion, that this flux and reflux of the spinal fluid greatly contributes to the movements of the brain, which may be observed during respiration, when the mass of the brain is partially deprived of its various coverings, and which movements he supposes are constantly going on during life, even when the cranium is entire.

Without discussing these latter conclusions, which appear to me inconsistent with the physical conditions of these nervous masses in the perfect state of the cranium and vertebral column, sufficient, I think, has been advanced to show, both the possibility and probability of rapid changes in the site of certain proportions of the cerebro-spinal fluid, under modifications of pressure, within the cranium or vertebral canal.*

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* The following case of chronic inflammation of the investing membranes of the brain, with copious serous effusion, presented a remarkable variation in the symptoms of paralysis, which might probably depend upon the varying site and amount of the serous effusion:—

A. S., æt. 40, a married woman, was admitted, under my care, into St. Bartholomew's Hospital, on November 3d, 1842. Her daughter informed me that her mother had been much addicted to spirit-drinking. About fifteen months ago she first began to complain of pain and weight in the head and limbs. About nine months since she fell down suddenly, insensible and motionless. Upon recovering her consciousness, muscular power generally was impaired, but especially on the right side of the body: her legs failed her in walking, so that she fell. From the time of this attack her memory has been bad; she has been occasionally excited, and has laboured under some delusions. Some weeks after this seizure, she was admitted into Guy's Hospital, and was there cupped on the temples, and blistered at the nape of the neck. She remained eleven weeks in that hospital, and was discharged much improved in bodily powers, but the mind still enfeebled.

On the day of her admission to St. Bartholomew's Hospital, her countenance was pallid, and her expression vacant. She could scarcely articulate, and, when she attempted to do so, the features were distorted; her tongue was tremulous, as well as the hands, when the forearms were extended. She fed herself with difficulty, spilling fluids as she carried them to the mouth; the lower extremities were cold. She drew up the legs slowly when told to do so; but experienced no pain when the integuments of the feet were severely pinched, although slight twitchings of the toes of the right foot were observed. Vision and hearing were apparently unaffected. She frequently placed her hand upon her head; and when asked if she had pain there, she replied, "No." She was reported to have power over the sphincters: there was, however, a considerable tumour in the hypogastrium, resembling the pregnant uterus; the catamenia were reported as regular. Upon the introduction of the catheter, nearly five pints of high-coloured ammoniacal urine were drawn off; the pulse 120, rather hard; the heart's sounds natural.

During the two succeeding days she was much excited, and so incoherent and violent as to require personal restraint. She succeeded in getting out of bed twice, and appeared to have recovered more power in the legs, as she was able to stand alone, although insecurely. Sensation appeared quite lost in the lower extremities, for, upon pricking the feet with a pin, she did not evince the slightest pain, although slight muscular contractions of the toes were observed; the tremulous state of the hands and tongue continued. She derived no benefit from local depletion from the head, nor from purgatives.

On the third day she became wildly delirious, vociferating and struggling violently, The foregoing observations naturally lead to an inquiry into the functions of this cerebro-spinal fluid. This extra-vascular serum appears to me to be supplemental to the other contents of the cranium: it is removable by pressure or absorption; at one time giving

the pulse was accelerated and hard. Twenty ounces of blood were taken from the temporal artery, and other remedies to control increased vascular action were also prescribed. After this she obtained several hours' sleep, and on the following day was quiet, more conscious, and able to reply to ordinary questions concerning her symptoms. At this time she appeared to have recovered sensation in the lower extremities, as they were drawn up in bed with an evident expression of pain when the feet were pinched or pricked. She lived for a fortnight longer, presenting a remarkable alternation between excitement and calm, between returning power and paralysis. On one day she had no command over the sphincters, and the lower limbs appeared almost powerless and insensible, but exhibiting slight involuntary movements when the feet were pricked. On other days she called for the bed-pan, and the legs were immediately drawn away with an expression of pain upon a slight amount of irritation. No other striking symptoms preceded her death, which occurred on the 22d November.

The body was examined twenty-four hours after death. The spinal cord was first examined while the head was hanging down over the end of the table. The membranes of the cord were natural; the fluid in the theca in ordinary quantity; the medulla spinalis appeared contracted, and of small size, not filling the canal; no alteration of structure in the substance of the cord: the posterior spinal artery was converted into a fibrous cord. Upon raising the head much serous fluid, with some blood, escaped from the foramen magnum into the spinal canal; this fluid probably amounted altogether (blood and serum) to half a pint. The dura mater presented a corrugated appearance when the cranium was opened, as if the membrane had been more distended; serous fluid escaped when the dura mater was divided. The arachnoid and pia mater covering the convolutions were slightly opaque; the pia mater was infiltrated with serum, and the convolutions widely separated from each other. The substance of the brain tougher than usual, but not more vascular, and without sanguineous extravasation. The lateral ventricles were distended with serous fluid, and their lining membrane very tough. There was much osseous deposit in the internal carotid artery. The thoracic and abdominal organs presented no remarkable changes of structure. The mucous membrane of the urinary bladder was vascular, pulpy, soft, and in parts covered with lymph. The ureters healthy. The mucous membrane lining the pelves of the kidneys was vascular, thickened, and granular. They, as well as the uriniferous tubules, contained some pus: the surfaces of both kidneys were studded with minute points of puriform fluid, deposited in the superficial tubules. These changes in the urinary organs were probably due to the repeated and long-continued retention of the urine.

place to an increased quantity of blood in the cranium; at another, making up for a deficiency of blood in the vessels in the head. This extra-vascular serum not merely acts as supplemental to the varying quantity of blood, but also to the variable quantity of nervous matter in the brain. Its quantity is in the inverse proportion to the quantity of this nervous matter. Thus, in hypertrophy of the brain there is a most remarkable deficiency of serum within the cranium; the brain, its ventricles, and membranes, are so devoid of this fluid that they are almost dry: on the contrary, in atrophy of the organ, the ventricles and membranes are distended with fluid.

This extra-vascular fluid may probably perform another office: perhaps through this cerebro-spinal fluid a more equable pressure is diffused over the whole mass of the brain and cord; and for the reception of this regulator of pressure may be the contrivance of those cavities called ventricles which dip into the central parts of the brain*. The sac of the arachnoid may subserve the same purpose.

The enclosure of the brain in a serous membrane with a free surface constantly lubricated by an appropriate fluid, has been maintained by some to indicate the existence of movements of the brain within the cranium, and which correspond with respiration. Ecker has availed himself of this anatomical peculiarity as an argument in support of the opinion, that those movements of the brain corresponding with respiration which may be so readily observed when the dura mater has been accidentally exposed, also take place when the skull is entire. It is certainly true that these movements of the brain during life are rendered probable, if we reason from the condition of other organs analogously invested by a serous sac. Thus, the heart, lungs, alimentary canal, &c. are all in constant motion, or capable of moving. Ecker* is partially supported in his opinion by Burdach, Magendie, and Flourens. J. Müller† says, that as long as the skull is perfect no respiratory movements of the brain can take place; the brain can suffer no change in volume. What has been asserted to the contrary is easily refuted from its physical impossibility. Longet also states‡, as long as the bones of the cranium are perfect no movements of the brain can take place.

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* Philosophical Transactions, 1814 and 1821: Paper from Sir Everard Home.

It may, then, be asked, of what use is the arachnoid? It has been of use in the early periods of life, when movements of the brain really took place.

It appears to me, that if any movements of the brain within the sac of the arachnoid do take place synchronously with the respiratory movements, they must be exceedingly slight so long as the skull is entire. But there does not appear to be any absolute impossibility to such movements, if we admit the ready locomotion of the cerebro-spinal serum in the manner of a flux and reflux. Indeed, the theory which has been advanced respecting the supplemental functions of this fluid assumes a variable volume of the whole brain, and such variation of volume necessarily implies certain movements of the surface of the brain in relation to the internal surface of the dura mater.

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* Op. cit. p. 114.

† Physiol. I. 224.

‡ Op. cit. p. 779.

The foregoing inquiry will elucidate many interesting phenomena observed in states of vascular congestion or depletion within the cranium. When arterial or venous congestion of the brain is suddenly induced, the first effect will be an increased pressure on all the contents of the cranium; this pressure will cause the expulsion of a portion of this extra-vascular serum into the spinal canal. On the other hand, when abstraction of blood from the cranium is effected, there is a tendency to shrinking of the encephalon; but the vacated space is immediately occupied by a certain quantity of this serum. But when the power of the heart is inordinately increased for any length of time by stimulants, general plethora, or hypertrophy of the left ventricle, a train of symptoms is remarked similar to those produced by varying degrees of mechanical pressure artificially exerted on the brain.

These effects of increased determination of blood to the brain may be witnessed even where there is no structural lesion of that organ, although the effects are probably partly obviated by the anatomical peculiarities just described: but they will be most strikingly displayed where there is pre-existing structural disease in the cranium.

When obstruction to the return of blood from the brain takes place, so that the blood becomes almost stagnant in the sinuses, that part of the force of the left ventricle (which, in the normal state of the cerebral circulation, is expended partly in propelling the blood onward through the capillaries towards the right auricle, and partly in distending the vessels through the cranium) is, under such circumstances, expended upon the interior surface of the cerebral blood-vessels. This pressure is partly sustained by the resistance of the vascular tissues, and the remainder is borne by the surrounding cerebral substance. Whatever this force may be, it becomes a source of increased pressure upon the cerebral substance; and the more so, according to the pre-existing morbid states of the encephalon and its vessels.

When the circulation is thus excited or obstructed, an obvious state of congestion of the integuments of the head and face is produced, and from the experiments I have detailed, it may, I think, be inferred, that a simultaneous congestion of the internal vessels of the cranium is formed.

In previously healthy conditions of the cranium, when it contains nothing but the brain and normal quantity of serous fluid, the cerebral substance may readily accommodate itself to a temporary increase of blood in its vessels (arterial or venous, or in both), and to the consequent pressure, by expulsion of a certain amount of serum; but when the cranium contains abnormal and unremoveable substances, then the brain cannot bear these accessions of vascular fulness, and consequent pressure.

In those pathological states of the encephalon where there is an increase in the quantity of solid matter within the cranium and a diminution of the quantity of extra-vascular serum, as in hypertrophy of the brain, tumors and cysts in that organ, and in large extravasations of blood on the surface, every cause which is capable of exciting the heart's action produces a notable increased disturbance of the functions of the brain. The variable character of the symptoms of cerebral disturbance in these permanent lesions within the cranium are thus probably accounted for by the variable vascular pressure. Andral has offered a nearly similar explanation of the occasional recurrence and intermittent character of cerebral symptoms, although their supposed cause, organic disease in the cranium, is permanent. It seems to me probable that many permanent structural lesions within the cranium do not affect the functions of the brain by pressure, except when there is some cause in operation capable of inducing vascular congestion, or when the lesion is of a mechanical nature, or is gradually increasing.

If the force of the contractions of the heart be diminished in these morbid states of the encephalon, there is usually a corresponding relief to the cerebral symptoms; but should the same diminution in the force of the circulation be produced in healthy states of the brain, the functions of the organ are suddenly annihilated from insufficient vascular pressure: syncope is the result.

Syncope is occasioned by insufficient vascular pressure on the brain, and not from the inadequate quantity of blood supplied to the brain and its vessels, as is commonly supposed.

In the most simple form of syncope, that which arises from a strong moral emotion in a previously healthy person, we see the single effect of want of due vascular pressure on the brain. In such cases the quantity and quality of the blood in the person's body are unaltered previous to the syncope, and the suspension of the cerebral functions arises solely from the diminished energy of the heart. The blood is no longer propelled with sufficient force from the left ventricle to maintain an adequate pressure on the cerebral substance. If such a person happen to be in the erect posture, the syncope is more rapid and complete; because the enfeebled muscular tissue of the heart is unable to sustain the arterial current of blood against the force of gravity, and preserve the proper degree of pressure on the brain. Let such a fainting person be placed in the horizontal posture, and, as is well known, consciousness quickly returns. But why? Because the enfeebled heart is equal to maintain the arterial current of blood in that favourable posture, and with it the requisite amount of vascular pressure on the brain. The same phenomena occur in syncope produced by hæmorrhage, although in this case it is not so easy to show that the suspension of the cerebral functions is occasioned solely by want of vascular pressure on its substance. It has been forcibly pointed out by Dr. Marshall Hall, that bleeding in the erect posture is the best method of ascertaining the power of the system to sustain the loss of blood, and of the propriety of bleeding as a remedial agent. It is a matter of daily experience that a small amount of blood taken from a person in the erect posture will cause syncope;

whereas double the amount of blood might have been taken from that person in the horizontal posture without producing a similar result. Hence the posture of the individual, and not the amount of blood abstracted, is the more efficient cause of the syncope. The effects of the erect posture in modifying the influence of the heart on the brain I have just described.

In extreme states of debility, from whatever cause produced, the mere sudden assumption of the erect posture is often adequate to induce an alarming, and sometimes fatal, syncope. In this posture the feeble heart is unable to project the blood against the force of gravity in the carotid and vertebral arteries, and the brain is suddenly deprived of the vascular pressure essential to the continuance of its functions. The influence of this cause of death was not unfrequently seen in our cholera hospitals, when that disease prevailed epidemically. Patients who were in states of collapse, but still in the enjoyment of the sensorial functions while reclining, upon assuming the erect posture died almost instantaneously.

There is another posture of the body which will, in some persons, induce syncope, and where the cause appears to be the sudden diminution of the momentum of the blood in the arteries of the head, and, consequently, an insufficient vascular pressure on the brain. If the arms be held extended in vertical lines above the head, this posture will quickly produce faintness in some persons. Under such circumstances, the heart has suddenly imposed upon it the additional labour of overcoming the effects of gravity on the blood in the arteries of the upper extremities; and the consequence is a diminution of the momentum of the blood in the arteries of the head.

I am the more anxious to direct attention to the foregoing explanation of the phenomena of syncope, because a very different opinion has been advanced in a recent work in extensive circulation among the junior members of the profession. Thus, in an Essay on Apoplexy*, it is asserted that syncope differs from apoplexy only in the extreme feebleness of the heart's action; but the cause producing loss of consciousness, sensation, and motion, is stated to be the same in both affections. In either case, it is said, owing to the peculiarities of the circulation within the cranium, *pressure* is exerted on the brain; and in some cases it is difficult to distinguish these states of apoplexy and syncope from each other. "Thus," continues the writer of this article, "either from increased or diminished action of the heart, pressure on the brain may be produced by over-distension of its vessels; in the first case, of its arteries, and in the second, of its veins." Here we find it promulgated that apoplexy and syncope are to be attributed to the same physical cause, viz. pressure on the brain: and that in syncope the pressure arises from the diminished action of the heart, occasioning fulness of the cerebral veins. Now, I believe, that so far from syncope being occasioned by pressure on the brain, it will be found, as I have stated† at some length, that every method of diminishing vascular pressure on the brain to any great extent, whether it be accomplished by depressing moral emotions, by sudden loss of blood, by the erect posture of the body, or by contrivances which diminish the momentum of the blood flowing towards the brain, will almost certainly induce syncope.

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* Library of Medicine, vol. ii. p. 92.

† Page 61.

But if syncope be produced by venous congestion, causing pressure on the brain, as maintained by the writer alluded to, would any practitioner of experience attempt to overcome syncope by the use of those remedies most likely to diminish venous congestion of the brain, and the consequent pressure on that organ? Would he be bold enough to place his fainting patient in the erect posture, or draw blood from the jugular veins?

I have also shown by experiments, that when an animal is bled to the point of fatal syncope, that, so far from finding venous congestion of the brain after death, all its vessels are, on the contrary, exsanguine*.

It appears to me, that syncope differs from apoplexy in every respect but in this one, viz. that in both there is a total temporary abolition of the functions of the brain. The causes producing the abolition, and the means to be employed to restore the functions of the brain, are generally quite opposite. Without presuming to be hypercritical, there is cause to regret that such erroneous doctrines as to the nature of so alarming a condition of the system as syncope should have been disseminated by modern writers.

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* Plate I.

It is unnecessary for me particularly to describe the remarkable disturbance of the functions of the brain which takes place in general anæmia. Does the long catalogue of nervous symptoms arise from the altered qualities of the blood in anæmia; or from an insufficient quantity of blood in the cerebral substance; or, lastly, from impaired vascular pressure on the substance of the brain? Without underrating the injurious effects of the altered qualities of the blood in general anæmia, on the brain and all the organs of the body, still I am inclined to the opinion that some of the most remarkable symptoms arise rather from insufficient vascular pressure than from an insufficient quantity of blood in the substance of the brain.

Simple anæmia certainly does not produce that train of symptoms which is usually ascribed to a want of due supply of blood to the brain. Probably there is no condition of the brain, not even that induced by repeated hæmorrhage, in which the substance of the organ is so completely anæmic as in genuine hypertrophy. In this rare cerebral affection the membranes and substance are found dry, and devoid of blood or serum; the medullary matter is as white and firm as blanc-mange, or hard-boiled white of egg. The cranium is already so completely filled by hypertrophy of the cerebral substance that the blood is unable to make its way through the vessels; and with all this bloodlessness of the organ, we witness none of the nervous symptoms of general anæmia. On the contrary, the symptoms are rather those commonly ascribed to the effects of inordinate supply of blood to the brain.

In these cases of hypertrophy of the brain the force of the heart is unimpaired; the blood is propelled with its normal force into the cerebral arteries, but it cannot make its way through the capillaries; and thus the static force of the heart is expended on the surrounding cerebral substance: so that, in anæmia of the brain from this cause, there are none of the symptoms present which accompany anæmia of the organ produced by hæmorrhage, in which condition there is insufficient power of the heart to produce the amount of vascular pressure essential to the functions of the brain. Hence we infer that the simple condition of anæmia of the brain, independent of diminished vascular pressure, is insufficient to produce the peculiar train of symptoms so often observed in general anæmia.

It is in general anæmia, caused by profuse hæmorrhage, that we witness the fearful catalogue of symptoms indicating disturbance of the nervous centres in their most aggravated form. In such a condition of the body, we remark, that whatever tends temporarily to assist the heart, or stimulate it to propel the blood more forcibly towards the brain, alleviates the nervous symptoms; on the contrary, whatever places the heart at greater disadvantage in propelling the blood to the brain, aggravates these nervous symptoms. The loss of consciousness in syncope, the convulsions after hæmorrhage, are often immediately terminated by the horizontal posture so favourable to the momentum of the blood in the carotid arteries.

For a number of curious and interesting cases illustrating the state of the nervous centres when the system is reduced to a state of general anæmia, either by loss of blood, or other debilitating causes, the work of Dr. Marshall Hall "On the Loss of Blood, &c." may be consulted with advantage. In one and all of these cases of disturbed functions of the brain, an immediate, but temporary, relief to the symptoms is afforded by horizontal posture, stimulants, and other means which favour the momentum of the blood moving through the carotid and vertebral arteries.

The senses of sight and hearing are often impaired or lost during states of general anæmia, but posture alone will sometimes restore these functions of the brain.

Dr. Abercrombie* relates the following remarkable instance of the effects of posture on the cerebral functions. A gentleman, aged 30, came to Edinburgh for advice in regard to an obscure affection, referred chiefly to the stomach, and which had reduced him to a state of extreme weakness and emaciation. As his debility had advanced he had become considerably deaf, and this affected him in a singular manner. When standing, or sitting upright, he was very deaf, but when he lay horizontally, with his head very low, he heard perfectly. If, when standing, he stooped forward, so as to produce flushing of his face, his hearing was perfect; and upon raising himself again he continued to hear distinctly as long as the flushing continued: as this went off, the deafness returned.

In the foregoing case Dr. Abercrombie supposed there must be a want of balance in the circulation within the brain, a diminished quantity of blood and momentum of blood in the cerebral arteries, with a corresponding increase of the blood in the cerebral veins.

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* Op. cit.

I think the history of this case of deafness, as recorded by Dr. Abercrombie, rather shows that the varying amount of vascular pressure was the cause both of the suspension and restoration of the cerebral functions.

We occasionally meet with instances of a still greater influence exercised by posture over the cerebral functions. It is an observation which has been frequently made, that many men of genius, poets and others engaged in literary composition, have enjoyed the most rapid flow of brilliant ideas while they have been resting in the horizontal posture. It would be difficult to account for the increased activity of the functions of the brain while such persons were reclining, excepting on the supposition of an increased stimulus to the brain from the more forcible access of blood to that organ. The effect would be probably different in persons naturally endowed with a powerful heart and vigorous circulation. The variable activity of the functions of the brain in particular individuals, according to the posture they assume, would appear to be explicable by having reference to the heart as a propelling organ, and to the condition of the circulation generally.

An interesting example of the influence of the momentum of the blood, and of varying vascular pressure upon the functions of the brain, and consequent activity of the mind, depending on posture, is recorded by Dr. Andrew Combe*. A boy, eleven years and a half old, of a mixed bilious and nervous temperament, with a languid circulation, and feebly-developed chest and heart, was so directly influenced by the degree of force with which the blood is supplied to the brain, that he seemed to be two different characters when sitting up or lying down. In the former attitude, when the head is scantily supplied with blood, he looked apathetic, and was sullen; whereas, upon lying down, when the circulation was assisted by the force of gravity, his real powers became manifest, and he was animated, talkative, and highly intelligent.

A still more remarkable instance of the same kind is recorded by M. Bricheteau, in an Essay on the Influence of the Circulation on the Cerebral Functions†. This writer adverts to the case of a student whose memory was treacherous, and who was in the habit of placing himself, not merely in the horizontal posture, but with his lower extremities elevated, and his head depending, when he wished to study with most effect. Bichat and some other physiologists have considered the functions of the brain so dependent upon the momentum of the blood in its vessels that they have not hesitated to state that, in animals and men where the neck is very long, and where, therefore, the brain is further removed from the dynamical influence of the heart, the faculties are more limited, and the cerebral functions less active:

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* Physiology: 1841. 10th Edition.

† Journ. Complement. des Sciences Médicales. Vol. iv. 1819. Paris.

whereas a short neck and approximation of the brain to the heart usually coincides with cerebral energy.

We may remark similar effects from diminished vascular pressure on the brain in the application of that powerful, but hazardous contrivance, the horizontal revolving bed. Dr. Darwin, I believe, invented this rotatory machine for the purpose of tranquillizing the nervous system, and procuring sleep*. It was subsequently employed to calm the violence of the furious maniac. Its mode of application is as follows. The patient is laid on his back, with his head close to a column or pivot, around which the bed is made to revolve with considerable velocity. A centrifugal force is thus generated, which, from the position of the patient, determines the blood from the head towards the lower extremities. This centrifugal force, thus suddenly created, powerfully diminishes the momentum of the blood moving into the cranium: the diminished arterial pressure on the cerebral substance soon produces a sense of exhaustion or complete syncope†.

I have adduced this as another illustration of the principle, that the suspension of the functions of the brain is produced by the diminished vascular pressure on its substance rather than by an inadequate supply of blood to the organ. In this last described experiment it is clear that neither the quantity nor the quality of the blood in the vascular system is affected by the generation of this new power. Neither can we ascribe the loss of cerebral functions to an alteration in the balance of the circulation within the cranium, that is, to an alteration in the relative quantities of blood in the arteries and veins. This centrifugal force must have an equal effect upon the blood in the arteries and veins of the brain, as well as upon the removable serum. I think we can only ascribe the effects to diminished vascular pressure.

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* Zoonomia, vol. ii. p. 608.

† Vide Commentaries on Insanity, by G. Man Burrows, M.D. London, 1828. Page 600.

On this interesting and important principle of pressure, I have endeavoured to point out that such a force is constantly in operation upon the cerebral substance; that this pressure is produced by vascular distension; that, in health, any cause which is capable of increasing or diminishing this vascular distension has the effect of disturbing the functions of the brain; that these effects of vascular distension would be more serious and frequent if parts of the contents of the cranium were not readily removable upon increase of vascular pressure; that, in pre-existing structural diseases of the encephalon, any increase of vascular distension causes much more serious disturbance of the cerebral functions, and the symptoms so produced are analogous to those of mechanical pressure on the brain.

I have also attempted to support the opinion, that variations of this vascular pressure are the causes of the intermitting character of the more urgent symptoms in cases of permanent disease within the cranium.

I have likewise endeavoured to explain the phenomena of syncope, however produced, on the principle of diminished momentum of blood in the arteries of the head, and consequent diminished vascular pressure on the cerebral substance, rather than on the principle that the brain is not supplied with a sufficient quantity of blood. And lastly, I have accounted for many of the symptoms of disturbance of the brain in general anæmia, upon the hypothesis of an insufficient vascular pressure on the substance of that organ.

The effects of diminished and unequal vascular pressure on the brain are strikingly manifested upon other occasions when one or both common carotids are temporarily compressed, or are suddenly and permanently closed by ligature or other means. It has long been known that interruption to the circulation of blood through one or both of these vessels was attended with disturbance to the functions of the brain. This subject has recently derived much elucidation from the inquiries of Longet*. and of Ecker†, but more particularly from the elaborate and carefully-compiled Essay of Dr. Norman Chevers‡. I shall not hesitate to avail myself of these sources of information, which have been published subsequent to my inquiries, and to draw from them some further facts which may illustrate the effects of diminished vascular pressure on the brain.

Numerous experiments on animals have been made from the earliest times that physiology has been cultivated, to ascertain the real nature of the effects upon the brain by tying the carotids. The most dissimilar and conflicting results have been obtained from these experiments. In some instances the simultaneous ligature of both common carotids has caused severe or even fatal results; while in others the symptoms have been slight, or there have been no injurious effects on the brain. It is most probable, as suggested by Dr. Chevers, that the differences in the results of this operation in the lower mammalia have depended rather upon some peculiarities in the condition of the animals themselves than upon the manner in which the operation has been performed. Whatever may be the effects of the ligature of both carotids in animals, we cannot infer or anticipate that they will be identical in the human subject, because in the lower animals the carotids contribute far less to the supply of arterial blood to the brain than the same vessels do in man.

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* Op. cit. pp. 800—808. † Op. cit.
‡ London Medical Gazette, vol. xxxvi. Oct. 1845.

If we refer, however, to recorded cases where both common carotids, or one carotid, has been suddenly closed by ligature in the human subject, although we shall remark a diversity in the effects on the brain, still some effects are generally visible. First, there are noticed symptoms attributable to diminished vascular pressure and supply of arterial blood in the brain; and secondly, those which arise from cerebral disorganization resulting from this interrupted supply of blood.

The following case clearly exhibits the effects of interruption to the circulation through both common carotid arteries.

Mr. Aston Key tied the right common carotid artery in a woman, aged 61 years, suffering from aneurism of the arteria innominata. In about one hour and a half after the operation she appeared asleep, the respiration being natural, with the exception of a snore. This noise gradually became fainter, and she expired in about two hours more, just four hours after the operation.*

Upon examining the body, it was found that the opening of the other (left) carotid from the arch of the aorta was nearly closed; it was scarcely one-tenth its natural size. The vertebral arteries were also rather small. The substance of the brain was healthy; its vessels sound, and containing the ordinary quantity of blood: there was a little serous effusion between the membranes.

There appears nothing to account for this woman's rapid death but the sudden diminution in the momentum of the blood in the cerebral arteries, occasioned by the closure of the only pervious carotid. The effects upon the cerebral functions observed after the above-recited operation are very similar to those witnessed in persons placed in the revolving bed, where, by a centrifugal force acting from the head, the momentum of the blood in the arteries of that cavity is rapidly diminished.

Dr. Chevers, in the essay already referred to, alludes to two other cases of simultaneous closure of the common carotids by ligature, and where the individuals perished in the course of twenty-four hours; and he arrives at the conclusion, that we have not any grounds for believing that a human being can survive the effects of sudden obliteration of both carotid arteries.

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* Medical Gazette, vol. vi. p. 703.

It is, however, well known that a similar result does not necessarily ensue upon the ligature of one common carotid artery in man: nevertheless, no inconsiderable number of those who have undergone this operation have exhibited a marked disturbance of the cerebral functions almost immediately after the occlusion of the artery, or have subsequently died hemiplegic, with extensive disorganization of the hemisphere of the cerebrum supplied by the obstructed artery. That such are the frequent results of this operation could be proved at length by a reference to the fourteen cases cited by Dr. Chevers, or to sixty-five cases alluded to by M. Longet, or to others the notes of which I have obtained from various sources.

In some of the above-mentioned cases, the symptoms of an affection of the brain came on so suddenly that they could only be ascribed to the interruption of the cerebral circulation by the closure of the artery. These symptoms of cerebral disturbance shortly after the operation were, faintness, giddiness, dizziness, loss of speech, delirium, insensibility. I am of opinion that these immediate symptoms result from the diminished and unequal vascular pressure on the brain.

But there is another train of cerebral symptoms which usually appear some hours, or a few days, after the operation, viz. more or less complete hemiplegia of the side opposite to the obstructed artery. If these hemiplegic persons sink as they usually do, more or less disorganization of the cerebrum on the side of the occluded artery is discovered.

These subsequent phenomena appear to me to arise from two causes; partly from the insufficient supply of blood to the disorganized hemisphere of the cerebrum, and partly from the compression of the exsanguined hemisphere by its fellow, the vessels of which still continue to be liberally supplied with blood.

In healthy states of the circulation within the cranium the forces distending the blood-vessels in either cerebral hemisphere are equal, opposite and counterbalance each other; but so soon as the free supply of blood to one cerebral hemisphere is cut off by the ligature on the common carotid, the vascular distension in the other hemisphere becomes a source of pressure on the exsanguined side. Hence, probably, the cause of the commencing hemiplegia, which gradually increases with the disorganization of the cerebral substance. I am inclined to attribute the successful termination to this operation in some cases to the opportune loss of blood from a wound in the throat prior to the application of the ligature; or the same happy result may be ascribed to a cautious preparatory venesection before the common carotid has been secured. By such loss of blood the circulation has been quieted, and the difference in the momentum of the blood in different parts of the brain has been, if not obviated, at any rate very much diminished. It might be objected that the effects upon tying one of the carotid arteries in the human subject are too diversified to admit of the foregoing explanation; but, in reply to such objection, it may be urged, that, although certain effects are usually produced by large abstraction of blood, still the results of blood-letting are very dissimilar in different individuals.

The remarkable effects on the functions of the brain produced by ligature of the carotids or by other methods of obstructing the circulation through those vessels, have induced different persons to resort to such proceedings in the treatment of some cerebral disorders, such as epilepsy, which are almost incurable by other means.

Thus Mr. Preston details* the effects of a ligature which he placed on the common carotid artery with the intention of controlling epilepsy. The patient, a man aged 25 years, resident in Calcutta, was subject to severe epileptic spasms after excitement or drinking of spirits, to which he was addicted. He was bled largely from the arm on the day preceding the operation, and also at the time of its performance. No serious cerebral symptoms ensued upon the application of the ligature, although the man suffered from pain in the head, which was relieved by the application of leeches. Two months after the operation he had had no return of the epileptic fits, nor any unpleasant effects from the ligature of the carotid. Upon another occasion the same gentleman applied a ligature, first, to the right carotid, and subsequently, about five weeks afterwards, to the left carotid artery, with the intention of relieving a case of cephalæa and partial palsy. Mr. Preston was of opinion, that, but for this operation, both his patients must have been either worse, or probably cut off by their respective diseases.

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* Calcutta Medical and Physical Transactions: quoted in London Medical Gazette, vol. x. p. 589.

The same principle on which Mr. Preston acted has also occasionally been employed by others to control cerebral and other affections supposed to be dependent upon increased momentum of blood in the vessels of a part. It was from an opinion that many diseases were produced by an increased momentum of blood in the vessels of the part, that the late Dr. Caleb Parry* employed compression of the carotid arteries to subdue mania, headache, vertigo, and likewise compression of other arteries, to relieve inflammatory diseases in other parts supplied by these vessels. Dr. Norman Chevers has enumerated† other instances where the compression of the carotids has been practised with success.

Although the ligature of the common carotid is attended with risk to life in some cases (perhaps in the proportion of one death in four operations), still experience proves that where proper precautions have been taken the operation is not so dangerous as many suppose. Therefore, in violent and hopeless cases of epilepsy and some kindred maladies, which are characterised by extreme cerebral congestion, it appears to me, that other remedies failing, this operation may be fairly resorted to. I am aware of the responsibility of advocating a remedy attended with risk to life; but are not all our best remedies most violent poisons in the hands of the unskilful? But this truth does not forbid their use by the more expert. So may this powerful method of influencing the cerebral circulation be justifiable in aggravated cases of the class referred to, and where the precept of Celsus, "satius est anceps remedium experiri quàm nullum," may be fairly put into practice.

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* Elements of Pathology and Therapeutics, p. 83.

† Loc. cit.

SECTION III.

OBSERVATIONS ON APOPLECTIC COMA.

If the opinions which have been advocated in the foregoing sections on the variable quantity of blood within the cranium, and on the effects of vascular pressure on the brain, be admitted as correct, they must tend to simplify the pathology of apoplexy.

In many highly-esteemed works, and even in those of comparatively recent date, we discover the most discordant explanations of the manner in which the apoplectic fit is produced.

"The opinion that apoplexy is immediately caused by an obstruction of the passage of the nervous fluid into the organs of sense and motion, has been the favourite hypothesis of physiologists, and seems more satisfactorily than any other to explain the manner in which the exciting causes act in producing the symptoms of the disease." Such is the explanation offered in a treatise of some repute*, and it is hardly necessary to remark how much this hypothesis is at variance with the opinions of pathologists at the present time.

There is probably no modern British writer who has contributed so largely to our knowledge of diseases of the brain as Dr. Abercrombie, or whose opinions on the pathology of apoplexy have been so universally accepted. Nevertheless, Dr. Abercrombie felt himself unable to explain the cause of some of the most prominent symptoms of the affection. He writes thus: "From the number and variety of the speculations entertained by different writers, we perceive the difficulties which attend the pathology of apoplexy, and learn the important fact, that apoplexy has, by extensive observation, been ascertained to be fatal without any morbid appearance in the brain, or with appearances so slight as to be altogether inadequate to account for the disease." He also points out "that there is a modification of the disease depending on a cause of a temporary nature, without any real injury done to the substance of the brain; and that the condition upon which this attack depends may be speedily removed, or it may be fatal without leaving any morbid appearance on the brain*."

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* Cooke: On Nervous Diseases, vol. i. p. 251.

In concluding this part of his history of apoplexy, the same author admits, that if he were asked what is that condition of the brain which produces coma, his answer must be, that he cannot tell; but that we are not therefore to sit down contented with this profession of our ignorance, but ought, on the contrary, to consider this conclusion as a position of much importance, from which we are to commence a new course of investigations." Such a confession from so able a pathologist offers a strong inducement to attempt a more satisfactory elucidation of this interesting point in the pathology of the brain.

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* Op. cit. p. 202—206.

What is coma? It consists in a suspension of the functions of the brain while those of the spinal cord remain more or less intact.

Hence, during coma consciousness is lost, volition is destroyed, sensation is annihilated, while all those functions which are performed involuntarily under the influence of the spinal and ganglionic nerves continue to be performed, but with diminished energy. We may next inquire what is the precise condition of the brain in coma, and what is the cause of coma?

It appears to me, that most inquirers into the subject have looked too exclusively, in cases of apoplexy, to one cause for the explanation of the complete or partial abolition of the cerebral functions. Mechanical pressure is supposed to be that cause; and, no doubt, in the majority of cases, it is some pressure which totally or partially annihilates the functions of the brain. But when a visible physical cause of pressure is not discovered in the brain of an apoplectic person, many cannot believe that pressure has ever been exerted there, and the cause of the apoplectic coma, therefore, appears inexplicable to them.

There are probably several causes capable of suspending the functions of the brain, and producing coma, and these causes are analogous to those which we experimentally find are adequate to destroy the functions of the cerebro-spinal nerves in any part of their course. These causes may be enumerated in the following order: first, pressure on the nervous fibres; secondly, division of the nervous substance; thirdly, disorganization of the nervous matter; fourthly, interrupted supply, or deficient momentum of blood in the nervous substance; and fifthly, the action of narcotics.

Whenever and wherever these causes can be brought to operate on the nervous fibres which emanate from the brain and spinal cord, we observe their functions are impaired or annihilated. In like manner, if these causes can be made to act on any limited part of the brain, its functions are partially suspended, and the more extensively these causes operate so are the cerebral functions more completely abrogated.

Each of these causes will, I believe, be found adequate to explain the fatal event in different cases of apoplexy; and when we cannot discover a physical cause of pressure in fatal cases of apoplexy, we shall generally be able to detect the presence, or previous operation, of some other of the causes I have just enumerated.

I have already remarked, that it was Dr. Abercrombie who directed the attention of the profession to the surprising fact, that so formidable a disease as apoplexy might occur and terminate fatally without leaving any morbid appearance in the brain. Burserius, in his Institutes of Medicine*, relates instances of this kind, and quotes from Vallisnieri, of Modena†, a passage wherein that writer states, that in several bodies of persons who had died of apoplexy, to the great amazement of the dissectors, not the smallest injury was discoverable either in the membranes of the brain, or in the cortical or medullary part, or in the ventricles, or in the vessels, or in any other part of the head.

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* Chap. 4—Apoplexy.

† A.D. 1725.

Dr. Cook has adverted to cases of apoplexy where, on examination of the head, nothing morbid or uncommon has been found*. Sir Gilbert Blane and others have accounted for this anomaly by supposing that the inquiries made in such cases were not sufficiently minute; and indeed it too often happens that in dissections after apoplexy the head only is examined. Thus, the celebrated Morgagni was in the habit of decapitating the bodies of patients who died apoplectic, and demonstrating the cerebral lesions in the public theatre, without any reference to the conditions of the other viscera of the body. No doubt his contemporaries adopted the same practice; and hence the value of those records of the lesions discovered in apoplexy is much diminished.

Dr. Abercrombie has recorded three fatal examples† of the kind of apoplexy which he designates as simple apoplexy, where there was no lesion of the brain, and where he could not account for the coma and subsequent death of the individuals.

In two of the three cases it is reported that all the usual remedies for apoplexy had been employed in the most active manner. In one of these patients not a vestige of disease could be discovered in the brain; and in the second no morbid appearance beyond a slight turgescence of the vessels on the surface of the brain. In the third case no medical assistance was sought for until one hour before the death of the patient; and here, upon dissection of the head, the veins on the surface of the brain were found turgid, and its substance, when cut into, exhibited a remarkable degree of vascularity[*].

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* Page 190, op. cit.

† Cases 98, 99, 100, op. cit.

That the morbid appearances in the brains of the first two patients should not have been more decided, does not astonish me, when I learn that all the usual remedies for apoplexy had been employed in the most active manner. Now we are also informed by Dr. Abercrombie[†] that the remedies upon which he placed reliance were large and repeated bloodlettings, active purgatives, cold applications to the scalp, aided by an elevated posture of the head, and the absence of all stimulants. Those who are led, by the experiments of Dr. Kellie, to believe that we cannot by our evacuations diminish in any material degree the quantity of blood in the head, may probably infer that the state of the blood-vessels in the brains of these apoplectic patients, as exhibited after death, was nearly the same as it had been at the time of the apoplectic seizure.

But if I may venture to rely upon the accuracy of the experiments which I have performed and detailed[‡], and upon certain other facts which I have related, and which illustrate the effects of hæmorrhage on the quantity of blood in the cerebral vessels, there surely can be no grounds for surprise that, after the active employment of bloodletting, and the other remedies just enumerated, no distension of the cerebral vessels should have been discovered in the first two cases; whereas in Dr. Abercrombie's third recorded case of simple apoplexy, where no such depleting remedies were resorted to previous to the fatal termination, the vessels of the membranes and substance of the brain were turgid throughout.

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[*] Case 100.

[†] Page 286.

[‡] Section I.

There appear to me just grounds for believing that in each of the cases to which I have here referred there must have been, at the time of the seizure, an intense vascular congestion adequate to the production of sudden pressure and apoplectic coma. Those who deny that the quantity of blood within the cranium can be increased, and especially those who assert that the heart has little or no influence on the cerebral circulation, and that "the phrase, determination of blood to the head, is without meaning*," must be perplexed to explain the cause of coma in those fatal cases of simple apoplexy where neither vascularity nor effusion of blood or serum is discovered within the cranium. Some of these pathologists ascribe the fatal result in such cases to a disturbance in the equilibrium of the arterial and venous blood in the brain. Dr. Clutterbuck ascribes the coma and death to the obstruction of the cerebral circulation occasioned by the distension of the arteries and compression of the veins.

It appears to me that the true explanation of the cause of the coma in these cases of so-called simple apoplexy, is to be found in the previous existence of a state of congestion of the vessels within the cranium, brought on either by determination of blood to the head, or detention of blood in that part. Then, as Dr. Watson has well expressed it, a tightening of the full vessels occasions extraordinary pressure on the nervous pulp; and hence the coma. But if this be the correct explanation of the production of the coma in the simple apoplexy of Abercrombie, why does the coma persist, and death so speedily ensue, although the vascular distension, the supposed cause of pressure, is removed by abstraction of blood, or other remedies, and, as we ascertain after death, the brain has sustained no structural lesion? This is a question worthy of consideration.

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* Article Apoplexy, Cyclopædia of Medicine.

The fatal event is probably to be ascribed to another cause. If, in these attacks, the pressure on the brain has been adequate to suspend consciousness for a time, and the respiration has become altogether involuntary, slow, and stertorous, the substance of the brain is gradually saturated with undecarbonized blood. The apoplectic person remains in a condition analogous to that of one whose rima glottidis is constricted, or who has been suffering from apnœa for some time. The apoplectic patient then dies, not simply from pressure or lesion of the brain, but from the effects of imperfect respiration.

Experience shows that these cases of simple apoplexy, if not relieved speedily, prove quickly fatal. A similar result is observed in other diseases where respiration is seriously obstructed, as in attacks of acute laryngitis, where, if the respiration has been greatly obstructed for some hours, until the face and lips have become livid, although respiration may be re-established by tracheotomy, it is seldom that life can be preserved by the operation; and yet the structural lesions in the larynx are inconsiderable. In both instances the cause of death is not the lesion of the organ primarily affected, but the presence of undecarbonized blood in the brain and other organs.

The same explanation may be offered of the sudden deaths of persons who have been resuscitated after drowning and hanging, and in whom there may have appeared every prospect of life being preserved, respiration and circulation having been re-established; and yet they gradually sink.

If just weight be allowed to these physiological considerations, I think we may be able to explain the cause of death in these cases of simple apoplexy when no lesions are detected in the brain; and if we reflect that in many of those cases of fatal apoplexy where the appearances are so slight as to be inadequate to account for the disease, large and repeated abstraction of blood had been practised, and active purgatives, constant cold, and an elevated posture of the head, had been resorted to, we shall not be surprised to find that the cerebral congestion, on which the apoplectic coma depended at the time of the seizure, has been entirely dissipated.

Other cases of so-called simple apoplexy are probably fatal from the circulation of poisoned, or narcotized blood through the nervous centres—the vital fluid being contaminated by urea, spirits, opium, or some other deleterious principle.

I will now apply my views on the circulation and vascular pressure within the cranium to the explanation of the pathology of serous and sanguineous apoplexy.

When a fit of apoplexy terminates fatally, and serum or blood is found effused within the cranium, it is commonly supposed that the effused serum, or the extravasated blood, must have caused a pressure adequate to suspend the function of the brain and destroy life.

As I much doubt the correctness of this explanation, I proceed to inquire whether the coma in these cases ought rightly to be attributed to the effusion, or to a state of congestion which precedes effusion.

I will first direct my remarks to the so-called cases of serous apoplexy. It is unnecessary, in the present day, to enter upon any lengthened arguments to prove that the diagnostic symptoms between serous and sanguineous apoplexy are more fanciful than real. M. Portal was one of the first to point out that the diagnosis between these two varieties could not be relied upon; he has narrated* several cases which were deemed examples of serous apoplexy during the lives of the patients, but which proved to be striking instances of sanguineous effusion. This eminent pathologist maintained that those cases of apoplexy where effusion of serum is discovered, are almost always the consequence of previous congestion of the blood-vessels; and if serous apoplexies do sometimes occur without previous vascular congestion in the brain, the circumstance is uncommon. It appears to me highly probable that, in such cases of fatal serous apoplexy without any appearance of vascular congestion, active depletion, and other subsidiary means, had removed the congestion which existed prior to the effusion. After a minute and lengthened inquiry into this part of the pathology of apoplexy, it appeared to Portal that all the facts agreed in proving that congestion of the blood-vessels is the primary phenomenon in apoplexy, and that the effusion of serum is only secondary. This sequence of events is analogous to what is observed in local dropsies in other parts of the body, which are often solely caused by vascular congestions, and are cured by depletion.*

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* Sur l'Apoplexie, p. 13.

Dr. Abercrombie advocated similar opinions upon this subject, and expressly states that serous effusion is not the cause of sudden apoplectic coma. He adopts nearly the same line of argument as that pursued by Portal, and shows: 1st, that the distinction which has been proposed betwixt sanguineous and serous apoplexy is not supported by the observation of the symptoms in such cases; 2dly, that in other parts of the body serous effusion is seldom a primary disease, and does not accumulate at once in such quantity as to induce urgent symptoms: it is therefore highly improbable that it should occur in the brain as a primary disease, and accumulate with such rapidity as to produce symptoms of apoplexy; 3dly, there is no proportion between the quantity of fluid and the apoplectic symptoms: the quantity of fluid may be small, and the apoplexy severe; or the fluid may be large in quantity, and the apoplexy slight; and finally, there may be most extensive serous effusion in the cranium, and no apoplectic symptoms at all.

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* Op. cit. p. 348-9.

The direct inference from these facts is, according to Dr. Abercrombie, that in fatal cases of apoplexy with serous effusion the presence of the fluid cannot be considered as the cause of the coma; and it seems probable that the affection which has been called serous apoplexy is to be considered as simple apoplexy, that is, cerebral congestion, terminating by effusion.

Those who are not satisfied with these conclusions of Portal and Abercrombie may find many additional proofs of the same view of the subject in the contributions of the late Dr. John Sims to the pathology of the brain*.

From the concurrence of all the best authorities, it would seem that the presence of serum in the brain renders that organ more susceptible, and liable to suffer from any congestion of its blood-vessels and the consequent vascular pressure, but the effused serum itself cannot be regarded as a cause of cerebral pressure adequate to the production of apoplectic coma.

It will, lastly, be interesting to investigate the cause of the coma in cases of apoplexy accompanied with extravasation of blood. When persons are attacked with apoplexy, and die comatose, or recover their consciousness for some time prior to death, and blood is found extravasated within the cranium, ought the effused blood to be regarded as the cause of the apoplectic coma?

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* 19th Vol. of the Transactions of the Medico-Chirurgical Society.

I am of opinion, that apoplectic coma is rarely dependent upon the extravasation of blood, although the concomitant paralysis undoubtedly is. Upon the examination of the brains of apoplectic patients, we sometimes find large extravasations of blood, which, from peculiar appearances in the clot, we feel assured have existed there for many days, or even weeks, and yet during the greater part of that period there has been no coma. Upon other occasions we discover small extravasations of blood within the brain, which, from their appearance, we can decide have only been effused a short time prior to death, and nevertheless there has been a well-marked coma in these cases. Hence, if pressure be regarded as the physical cause of apoplectic coma, and that pressure is supposed to be occasioned by the extravasated blood, then we must account for the paradox of a small extravasation producing a coma which terminates fatally, and a large effusion of blood having no such effect.

I shall proceed to the narration of two cases of extensive cerebral hæmorrhage, in which, although the quantity effused was considerable, still coma was only a transient symptom.

Mrs. G., æt. 65, a respectable person in limited circumstances, was admitted under my care into St. Bartholomew's Hospital, on October 1, 1842. The early history of her case was obtained from my friend Mr. Goodhart, of Camden Town. She was the mother of four children, temperate, and had suffered recurring attacks of insanity of some weeks' duration at an earlier period of her life. The last attack had occurred nine years previously. Upon getting out of bed about seven years since she fell down insensible, and remained so an hour, and from that time she had occasionally lost her speech for a few minutes. In the forenoon of Sept. 12th, she had complained of vertigo and drowsiness while engaged in her domestic affairs. She did not fall, or lose her consciousness, but contrived to get up stairs to her bed-room. She was assisted to her bed, where she remained perfectly sensible for some hours; but stupor increased, so that towards evening she could not be roused at all. Her family now became alarmed, and sent for medical assistance. She was found lying on her back, perfectly insensible, her face pale, and expression placid; hands cold; breathing natural; pulse 120, small and feeble; pupils dilated, and insensible to the influence of light. Leeches were applied to the temples, a blister to the back of the neck, and a grain of calomel was given every hour.

On the following day she was restless, delirious, and could hardly be kept in her bed.

At the expiration of a few days her gums became slightly affected by the mercury, and her general condition improved; so much so, that at the expiration of nine days she was able to recognise her relatives, and answer questions rationally. At the end of three weeks she was removed to the Hospital.

At this period her countenance was heavy-looking, and expressive of long suffering. Her articulation was slow and imperfect. Consciousness appeared to be sometimes lost, but when spoken to she gave rational answers. She said she had no pain in the head, or giddiness, but complained of pain in her back and the lower part of the abdomen. The sensibility of the surface appeared unimpaired, and she was able to move all her extremities, though with some difficulty. Pulse 100, rather firm; bowels open; bladder distended with urine. If the case had not been clear from the history, the stupor and debility might have been suspected to have arisen from an advanced stage of typhus.

On the following day her countenance was haggard; her eyes fixed and vacant; she was roused with difficulty; her articulation imperfect, and she answered incoherently. She gradually became comatose, and sank on the third day after her admission. An examination of the body was made twenty-three hours after death.

The dura mater was more than usually adherent to the cranium. About an ounce and a half of coagulated and brownish blood was effused beneath the cerebral arachnoid over the left hemisphere and at the base of the brain. There was also a small quantity of blood effused in the tissue of the cerebral pia mater at different points, and its large vessels were generally turgid with blood. There was a large clot of blood, probably an ounce, effused into the anterior part of each anterior lobe of the cerebrum. Both clots were firm, and towards their centres brownish, and dry. In the centre of the clot in the left lobe there was a cyst, filled with blood more fluid than that around it. The substance of the anterior lobes around the effused blood was softened, broken down, and discoloured.

All the ventricles, although not distended, contained clots of soft and uniformly black blood. The cerebellum was healthy throughout.

There was a considerable quantity of blood effused into the tissue of the pia mater of the spinal cord, and especially over the middle portion. The greater part of this blood was coagulated, and uniformly black, but the intervening portions of pia mater were red, stained by blood. There was much more on the posterior than on the anterior surface of the cord, also some spots of coagulum in the cauda equina*.

All the large vessels of the cord were full, and on the surface of the pia mater there were several small cartilaginous plates. The quantity of blood effused around the cord was calculated at half an ounce†.

The changes which had gone forward in the extravasations into both anterior lobes, and into the surrounding cerebral substance, left little doubt that they were the cause of the symptoms which developed themselves so gradually when this patient was attacked three weeks prior to her death: while the appearances of the blood on the surface and in the ventricles of the brain, as well as on the surface of the cord, led me to the inference that it had been effused soon after her arrival at the Hospital, and perhaps not more than forty-eight hours before her death.

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* From considerations which have been detailed in Section II., it appears to me probable that the blood which was found effused beneath the investing membranes of the spinal cord had made its way there from the cerebral ventricles.

† A preparation and drawing of the spinal cord are preserved in the Museum of St. Bartholomew's Hospital.

Indeed, there was much reason to suppose, that the excitement and exertion consequent on her removal from Camden Town to the Hospital, had so disturbed the circulation as to cause this second hæmorrhage, which was the immediate cause of her death. But to return to the point which I desire to illustrate by the preceding case.

Is it not surprising, that a woman, aged 65, who had long been suffering from cerebral affections, should so rapidly and to such an extent recover consciousness, memory, sight, speech, hearing, sensibility of the surface, and voluntary power over the extremities, while both anterior lobes of the cerebrum contained large clots of blood, and their substance was so seriously disorganized? When we reflect how many of the mental faculties are supposed by some physiologists to be exercised through organs situated in their anterior lobes, it is very difficult to understand how they were restored to the extent I have described, in the preceding case.

I shall narrate another case to illustrate the real effects resulting from copious extravasation into the brain.

Eliza M., aged 30, was admitted into St. Bartholomew's Hospital, September 8th, 1843.

The following account was obtained with difficulty from herself and friends:—She was married, and the mother of four children. About a month or so previous to the birth of her second child, she was suddenly seized with a fit, being convulsed, and losing her consciousness: she remained weak for some time afterwards. About a month after her second confinement, she had another fit. Five weeks before admission she was delivered of her fourth child: about a week afterwards she was seized with a similar fit, only much more severe than the preceding. She was unconscious in the fit; upon coming to, she found she had lost the use of the limbs of one side. At the date of her entrance into the hospital she had partially recovered from the hemiplegia: her countenance was vacant; the pupils dilated, acting very sluggishly; the mouth drawn to the right side; speech indistinct; she complained of pain at the top and back of the head, with great weakness; vertigo and impaired vision. Pulse 112, sharp and contracted; bowels obstinately confined.

She had been bled from the arm, blistered and purged, at the time of the apoplectic fit. Purgatives were now prescribed, and during the first fortnight of her residence in the hospital she gradually improved. At the end of that time she was able to sit up in bed, was more sensible, was able to dress herself, brush her hair, and feed herself. The facial muscles of the left side were still paralysed. On the morning of the fifteenth day she became convulsed; her eyes were fixed, her breathing stertorous, and she was quite unconscious; her face flushed; her limbs rigid, particularly on the right side. In spite of abstraction of blood and other remedies, the coma became more profound, and she died at the expiration of twelve hours from the seizure.

The body was examined forty-seven hours after death.

The calvarium was thick and heavy; the meningeal vessels were distended with blood; no fluid in the membranes; the convolutions of the upper surface of brain were white and dry; the right hemisphere appeared larger than the left. On slicing the right hemisphere, a diffused yellow staining of its substance was manifest. On continuing sections downwards, the stain became deeper and more circumscribed. Immediately external to the lateral ventricle there was a large, somewhat hard, and apparently old clot of blood; an irregular separation of the red particles from the fibrin had taken place; the surrounding cerebral substance was soft, pulpy, and broken down, and of a dirty yellow colour; the corpus striatum, and part of the optic thalamus, were likewise broken down; there was no appearance of blood in this lateral ventricle.

In the left corpus striatum, and thalamus opticus, just beneath the surface, there was a small clot and cicatrix, evidently of much longer standing than that on the right side. There was likewise a clot of recently-effused dark-coloured blood, extending nearly across the tuber annulare*, and another of the same recent date on the surface of the posterior lobe of the right hemisphere. The arteries at the base of the brain were slightly diseased.

The heart was firmly contracted; its left ventricle hypertrophied, and the mitral valves a little thickened. Considerable emphysema of the lungs was discovered. Both kidneys were small, the cortical parts almost wanting, and the tubular parts very granular, with some cysts. Blood, of a dark colour, was found effused beneath the mucous membrane of the small intestines nearly throughout their whole extent.

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* A preparation of this is preserved in the Museum of St. Bartholomew's Hospital.

The examination of this brain was interesting and instructive, inasmuch as it exhibited the appearance of three several clots of blood which had been extravasated at periods of two years, six weeks, and twelve hours respectively prior to the death of the patient. It was also worthy of remark, that, although there was such copious extravasation of blood into the upper part of the right hemisphere, yet the mental faculties had recovered to so great an extent, and she had regained power over the extremities of the left side, while some of the muscles of the face alone remained palsied prior to the fatal hæmorrhage into the tuber annulare. There were many causes capable of inducing apoplectic coma and cerebral hæmorrhage present in this case. First, there was emphysema of both lungs to obstruct the pulmonary circulation, and to cause congestion of the right chambers of the heart, and consequently of the cerebral veins; secondly, there was hypertrophy of the left ventricle to distend the cerebral arteries; thirdly, there was disease of the coats of the cerebral vessels; and lastly, there were granulated kidneys, and consequently a poisoned blood capable of narcotizing the system. And what was the result? This woman, who was only thirty years of age, had had no less than four apoplectic attacks in about the space of three years, and the traces of three of these were very conspicuous in the brain.

My object in directing attention to the two cases of apoplexy above related—and many others of a similar character might be cited—is to show that copious extravasation of blood into the brain cannot by itself be regarded as the cause of apoplectic coma; although it is of the paralysis concomitant with the coma, and which remains after the coma has disappeared.

Unless blood be effused towards the medulla oblongata, and thus interrupt the continuity of the nervous substance between the brain and the upper part of the spinal cord, there appears to be something beyond effusion of blood required to produce fatal apoplectic coma. This difficulty had not escaped the attention of Dr. Abercrombie, who remarks, there is some reason to believe that extravasation of very small extent, in fatal cases of apoplexy, may sometimes be considered as the effect of the state of simple or congestive apoplexy; and that in these instances the fatal event is not to be ascribed to the extravasation, but to the state of simple apoplexy, which we know may be fatal without either extravasation or effusion*. And I would add, that in such fatal cases the state of congestion is often not discovered after death, because a most active depletion has been employed, which has emptied the blood-vessels, although it was unequal to remove the extravasation. When extravasation of blood within the cranium takes place very slowly, as from the rupture of the diseased coats of an artery, independent of determination of blood to the brain, or general congestion of its vessels, it is highly probable that the effusion does not produce the symptoms of apoplectic coma, but gives rise to some modification of hemiplegia, the paralysis being to a greater or less extent, according to the situation and quantity of the effusion. As long as extravasation of blood is actually going on, while the blood is pouring forth, it most probably produces pressure on the surrounding cerebral substance, just as the blood escaping from a divided artery in any other part of the body would compress any obstacle with a force equal to the momentum with which the blood was circulating in that vessel. When cerebral hæmorrhage has stopped, I suspect the blood ceases to be a real source of general pressure, although, as it increases the quantity of extra-vascular matter in the cranium, it also offers additional resistance to the entrance of the normal quantity of blood into that cavity; hence healthy vascular distension becomes excessive, and the symptoms of general cerebral pressure are easily developed. Thus, the compression produced by extravasation will depend more on the rapidity and situation of the effusion than on the amount. If the effusion be slow, and not near to the base, although the amount be considerable, the effects will be slight in comparison.

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* Op. cit. p. 253.

I therefore infer, that in the larger number of cases of apoplexy accompanied with extravasation of blood, the coma is to be attributed to antecedent or co-existing cerebral congestion; while the paralysis, which is more durable, is dependent upon the limited local mischief produced by the extravasation. The close affinity between apoplexy succeeded by hemiplegia, and sudden hemiplegia unpreceded by apoplexy, has long been recognised. Each of these affections is usually connected with extravasation of blood within the cranium. In the former case, the hæmorrhage is associated with vascular congestion; in the latter, the congestion is probably not present.

From the foregoing inquiry into the different lesions discovered in fatal cases of apoplexy, it would appear that all the symptoms of apoplectic coma may exist without any cerebral effusion; and that effusions of serum or blood may exist to a very large extent within the cranium, and yet there shall be no apoplectic coma.

Again, a person may be in a state of apoplectic coma for many hours, entirely recover from the coma, but shortly afterwards die, when effusion of serum or blood will be discovered in the brain.

Now, admitting that cerebral pressure is the physical cause of the coma in apoplexy, I think the effused fluid cannot be regarded as the "vera causa" of that pressure; otherwise the definition of the cause of a morbid action, "præsens, morbum facit; mutata, mutat; sublata, tollit," is not correct: for we may witness the supposed cause and coma co-existing; coma without its supposed cause, or the supposed cause without the coma: and lastly, the coma may have existed with the supposed cause, and the former shall disappear while the latter remains. Hence it appears, that apoplectic coma may exist without effusion, and cerebral effusions to a great extent may exist without coma. This supports the opinion already expressed, that in a vast majority of cases of apoplexy the coma is attributable to the pressure induced by vascular congestion. It is not meant to assert that other causes may not annihilate the functions of the brain, and cause coma, as, for example, the circulation of venous blood through the organ, but the foregoing remarks apply to the coma of apoplexy.

But if this derangement in the circulation of the brain is alone capable of producing so serious a result as coma, it may be properly asked, why is not apoplectic coma produced by those frequently-recurring causes of determination of blood to the brain, such as violent exercise, strong mental emotions, and intemperance?

Dr. Abercrombie thought it probable that there were some provisions by which the effects of these causes were averted, though, in certain conditions of the system, each of them may be capable of producing perfect apoplexy. These protections, according to Dr. Abercrombie, are the course of the arteries of the brain through tortuous canals of bone, and the anatomical arrangement of the sinuses of the dura mater. By the first-mentioned anatomical peculiarity, any sudden increase in the momentum of the blood flowing to the cranium may be diminished; and, from the construction of the sinuses of the dura mater, these channels for the return of blood from the brain are kept constantly pervious, and are not liable to have their areas either increased or diminished in any considerable degree. It appears to me that both of these peculiarities of the cranial vessels contribute to the preservation of a more uniform amount of vascular pressure on the substance of the brain, and of a more easy circulation of blood within the cranium.

In addition to the above-mentioned protections, it appears to me that the existence of the extra-vascular serum within the cranium, and which is capable of so readily descending from that cavity to the spinal canal, must, inasmuch as it is but supplemental to the other contents of the cranium, afford an additional protection to the brain against the effects of any sudden congestion of its blood-vessels.

ON THE CONNECTION BETWEEN AFFECTIONS OF THE BRAIN AND DISEASES OF THE HEART.

SECTION IV.

ON THE CONNECTION BETWEEN APOPLEXY AND HEMIPLEGIA WITH DISEASES OF THE HEART.

The diagnosis of diseases of the heart has occupied so much attention during the last twenty years, and has arrived at such a high degree of accuracy, that it is almost unreasonable to expect, at the present time, any considerable addition to our knowledge of this part of the history of cardiac affections.

But it appears to me, that the full extent of the influence of diseases of the heart in disturbing the functions, or producing actual structural changes in other organs, and especially of the brain, has not been thoroughly estimated by writers on the diseases of that organ, and certainly not by the mass of the profession.

I therefore propose, in this and the succeeding sections, to investigate this connection between affections of the brain and diseases of the heart. The result of this inquiry will be, to prove a much greater dependence of structural and functional disorders of the brain upon diseases of the heart, both acute and chronic, than is commonly supposed.

It will be my endeavour, in this section, to illustrate the connection which subsists between apoplexy and hemiplegia with important structural changes in the heart. Many writers, when discussing the etiology of these cerebral affections, have enumerated hypertrophy, and some other structural changes in the heart, among the predisposing causes; but the frequency of the relation between these cerebral disorders and diseases of the heart has, I believe, never yet been fully estimated. This point in the history of these serious disorders of the nervous system is not one of mere pathological interest; but, if rightly understood, will be found to afford valuable indications towards the formation of a correct prognosis, as well as to the successful treatment, of both complaints.

I have already given (Part I., Sect. III.) what I deem the correct explanation of the cause of the coma in the apoplectic fit, and have shown, that all the principal symptoms in that state are primarily attributable to vascular congestion, producing cerebral pressure. Now it is reasonable to expect, that hypertrophy, dilatation, and valvular diseases of the heart, which are such constant causes of congestion in other parts of the body, would be frequently found to be coexisting with similar conditions of the vessels within the cranium. It must, I think, be acknowledged, that such important changes in the heart as I have just alluded to, do affect the circulation throughout the body; but more especially in those organs where the circulation appears to be under the most direct influence of the heart. Now, of these organs, undoubtedly the lungs stand in the first rank, and the brain in the next.

It would likewise be expected, in cases of effusion of serum, or extravasation of blood within the cranium, to find those same lesions of the heart which are so frequently remarked to be coincident with dropsies and hæmorrhages in other parts of the body.

Nevertheless, writers of authority are much divided in opinion as to the influence of these morbid conditions of the heart in causing apoplexy and hemiplegia. Believing that much further improvement in the treatment of these diseases, and many other hitherto obscure nervous affections, will result from more clearly defined notions on this relation between cerebral disorders and structural changes in the heart, I shall proceed, first, to collate the opinions of some of the most influential writers on diseases of the brain; and then detail additional facts, which I have had an opportunity of observing, and which afford the means for solving this disputed question. From a tabular synopsis of all the facts, I shall endeavour to establish certain propositions, which, if correct, ought to modify the general and routine treatment of apoplexy recommended by most writers on that disease.

If reference be made to the opinions of those physicians who were regarded as authorities at the commencement of the present century, and whose writings present a faithful synopsis of the then state of medical knowledge, it will be found that little was known about diseases of the heart, or their influence in producing diseases of the brain.

The learned Burserius* makes no express allusion to diseases of the heart among the remote causes of apoplexy. After enumerating the most commonly acknowledged causes, he thus continues:—"To these should likewise be added certain other morbid states of the body, which are said often to originate apoplexy, namely, diseases of the aorta, and organic diseases of the præcordia or abdomen." Cullen carefully enumerated† all the supposed causes of apoplexy, and particularly pointed out the morbid conditions which prevent the free return of blood from the vessels of the head towards the heart; but he nowhere alludes to structural diseases of the heart among the causes of apoplexy. This eminent physician was, of course, equally unaware of the influence which a cardiac affection would have upon the usual treatment of apoplexy. Dr. Cooke, who made such deep research into ancient writers on apoplexy and palsy, does not place structural lesions of the heart among the causes of those disorders.

He remarks‡, that apoplexy is not unfrequently sympathetic of, connected with, or caused by, other diseases. He refers to numerous examples of various diseases connected with or causing apoplexy, related by Bonetus, Morgagni, Sydenham, Sauvages, &c.; but how these combinations take place, or how these diseases influence each other, we do not know, according to Dr. Cooke. Indeed, it does not appear that much attention was paid to the connection between lesions of the heart and apoplexy, as causes and effects, until the publication of Portal's work. This physician was much in advance of his contemporaries in England and Germany, in his knowledge of the pathology of apoplexy. After enumerating the usual catalogue of supposed causes of apoplexy, he expressly mentions every thing which is capable of retarding the return of blood from the brain; and this, he remarks, requires particular attention, for apoplexy is sometimes manifestly produced by diseases which have their seat in the organs of respiration.* Again, he remarks, that in persons who die of apoplexy, the heart is sometimes found diseased; and, indeed, that the first cause of the apoplexy sometimes resides in that organ.

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* Institutions of the Practice of Medicine.—Translated by W. Cullen Browne, 1800.

† First Lines, &c. Vol. ii., Parag. 1108.

‡ Op. cit. p. 246.

The lesions Portal principally discovered were enlargements of the right cavities of the heart, with thickening or attenuation of their walls, combined with distension of these cavities, of the vena cava superior, and of the jugulars, up to the brain itself. Hence, he points out how the arteries of the brain cannot empty their contents into the corresponding veins, and thus will arise a congestion of blood which will produce apoplexy. But the walls of the left ventricle, he continues, have also been found greatly thickened in persons who have died of apoplexy; and hence it has been supposed, that this ventricle must have driven the blood into the brain with more force and in a larger quantity, in a given time, than occurs in health, and so must have produced the apoplexy. This, however, he is of opinion is not proved; but considers it probable this thickening of the walls of the left ventricle may arise from deposit of fat, or other disease of its muscular fibres, which would be unfavourable to the action of the ventricle. But if, with thickening of the walls, the muscular structure of the heart is in its natural state, then its contractions may be too violent, and the blood be driven with too much force into the aorta, and hence into the brain, so that in this way apoplexy may occur."*

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* Page 343.

I have given these quotations from the work of Portal at some length, because it appears that he had anticipated many others in explaining this important influence of diseases of the heart upon the brain in producing apoplexy, although his merits have not been sufficiently acknowledged by modern writers.

The peculiar doctrines relating to the circulation within the cranium advanced by Dr. Kellie, and supported by a series of experiments, which I have already considered, caused that physician, and several contemporary British writers on apoplexy, either to deny altogether or to disregard the influence of the heart in the production of cerebral affections. Thus, soon after the publication of Dr. Kellie's experiments and views on the cerebral circulation, he further maintained† that, in a sound condition of the brain and its vessels, such diseases of the heart (meaning valvular diseases, and hypertrophy of muscular substance) have little or no tendency to produce plethora, congestion, or disordered circulation within the head, nor, by consequence, lethargy, palsy, or apoplexy; although the livid, bloated, and sometimes swollen countenance, and the turgid, throbbing neck, bear ample testimony to the existence of plethora, obstruction, and congestion in the vessels on the exterior of the cranium. He adds, that of the several cases of enlargement, and other structural diseases of the heart, which had come under his own observation, not one of the patients had lethargic or apoplectic symptoms. One, only, had a partial paralytic affection of the right arm. The results of my own clinical observations, as well as of others, which I shall presently adduce, are quite at variance with this conclusion of Dr. Kellie.

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* Page 343, op. cit.

† On Congestion of the Brain. Med. Chir. Trans. of Edinburgh, Vol. i.

I have already referred to the opinions entertained by Dr. Abercrombie on the peculiarities of the circulation within the cranium. It is surprising that that distinguished physician, in treating of apoplectic and hemiplegic affections, has so entirely omitted all reference to the influence of diseases of the heart in producing such cerebral disorders. In the numerous dissections of apoplectic patients recorded by that author, the condition of the heart is scarcely ever mentioned; and in the majority of cases it would appear not to have been examined at all. Moreover, in the consideration of the treatment of apoplexy, no allusion is made by him to the complication of that disorder with cardiac disease.

A modern author, in analysing the causes of cerebral apoplexy, writes thus* :—"There may be great diversity with respect to the force and velocity of the circulation in the brain; the absolute quantity of blood in the vessels remaining still the same. In this way the functions may be more or less excited, or more or less disturbed. These changes in the state of the cerebral circulation are all independent of the heart, the action of which has but little influence over the brain or its functions. The expression, therefore, determination of blood to the head, in such general use, appears to be unfounded, as implying that the quantity of blood impelled to the brain, and the force of the circulation there, depend in any material degree upon the heart's action, instead of the action of the cerebral vessels themselves. The phrase, determination of blood to the brain is, therefore," concludes Dr. Clutterbuck, "without meaning."

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* Article Cerebral Apoplexy: Cyclopædia of Medicine.

If one of the most esteemed British authors upon diseases of the brain altogether neglects the influence of cardiac affections on apoplexy and kindred cerebral diseases, while others positively state that changes in the cerebral circulation are all independent of the heart, it becomes a duty on those who enjoy large opportunities of observing diseases, to investigate such statements, and, if inaccurate, to disprove them.

We now arrive at the consideration of the opinions of those who have both carefully studied the general symptoms of cardiac diseases, and availed themselves of the improved methods of investigating diseases of the heart.

In his General Observations on Apoplexy*, Dr. R.

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* Medical Reports, vol. ii. p. 327.

Bright remarks, that upon inquiry into the previous history of apoplectic patients, we not unfrequently find strong evidence of disease in the heart or its great vessels, or of great obstruction in the lungs, or of derangement in the kidneys, calculated to interfere with the healthy functions of other organs. Thus, although this able physician has directed attention to this point in the history of apoplectic patients, still the condition of the heart is seldom reported in the accounts of the dissections of his cases of apoplexy; and he makes no reference to this important complication when discussing the treatment of the disease.

The pathological opinions of Andral, founded upon extensive clinical observations, and unbiassed by any exclusive theory, have obtained a well-deserved authority in England. Andral declares that he has so often marked the coincidence of cerebral hæmorrhage and hypertrophy of the heart, that he thinks it fair to suppose this lesion of the heart may tend to the extravasation of blood in the brain, and consequently to apoplexy. This physician has recorded twenty-five fatal cases of apoplexy resulting from congestion or hæmorrhage in the brain, and in fifteen of these the heart was found notably diseased.*

The impulse given to the study of diseases of the heart in England by the publication of the late Dr. Hope's complete Treatise on that subject, must be acknowledged by all candid persons. The very strong opinions expressed by that writer upon the connexion between diseases of the brain and those of the heart, induced me, several years ago, to test those statements by frequent clinical observation; and, as far as my experience supports me, I can pronounce his opinions to be generally correct.

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* Clinical Medicine, vol. v.

The instances of apoplexy supervening on hypertrophy of the heart had been so frequently noticed by Dr. Hope, that he considered the relation of the two affections as that of cause and effect; and this he held to be one of the best established doctrines of modern pathology. The total number of cases of apoplexy from hypertrophy of the heart which he had observed exceeded those arising from all other causes; whence he was led to coincide in opinion with MM. Bertin and Bouillaud, that hypertrophy predisposes more strongly to apoplexy than what is termed the apoplectic constitution itself; and that in most instances those who present the apoplectic constitution in conjunction with symptoms of determination of blood to the head, are at the same time affected with hypertrophy of heart. This opinion is strongly corroborated by the observations of M. Richerand*, who states, that his repeated examinations of the bodies of apoplectic patients have proved to his satisfaction that the excessive power of the left ventricle of the heart more directly tends to the production of apoplexy, than the short neck and large head, which, according to most writers, constitutes the apoplectic constitution. Among the facts in confirmation of this statement, M. Richerand details the particulars of the death of the celebrated physician and philosopher, M. Cabanis. In April 1807, this learned man was attacked with apoplexy, from which he partially recovered; but in the ensuing autumn suffered from two more seizures, and in the following spring a more violent attack destroyed him. The examination of his body displayed an immense hypertrophy of the left ventricle of the heart, which was an inch in thickness, and three times its normal size. About eight ounces of blood were found extravasated in the brain.

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* Journal Complemen. vol. iv. p. 26.

Dr. Copland, in his learned work, states*, that the frequency of apoplexy, or paralysis, in advanced cardiac disease, especially hypertrophy of the left side of the heart, has led him to believe that more than mere coincidence subsists between the two lesions; and he suggests the great probability that a disposition to disease in the whole vascular system, and especially in the cerebral vessels, is often associated with cardiac disease. This combination must favour the occurrence of cerebral hæmorrhage whenever the circulation through the heart is materially altered from its normal state.

Such, then, are the diversified opinions upon this point of cerebral pathology, which, amidst so many conflicting authorities, is left quite undecided. This should be avoided if possible.

With the hope of placing this subject in a clearer point of view, I have endeavoured to arrange a table, showing how often the heart may be expected to be diseased in any given number of cases of apoplexy and hemiplegia. But in this attempt I have experienced much difficulty. It has been so commonly the practice, in the examinations of the bodies of apoplectic patients, to remain content with the lesions discovered in the brain, that few authors afford the precise information essential to forming a calculation of the relative frequency of diseases of the heart in cases of apoplexy and hemiplegia.

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* Dictionary of Medicine: article Apoplexy.

The sources from which I have been able to obtain the required data are few. They are the Clinique Medicale of M. Andral, Dr. Hope's work on Diseases of the Heart, Dr. Clendinning's Croonian Lectures*, my own hospital and private case-books, the Essay of M. Bricheteau†, and a thesis on apoplexy by M. Guillemin‡, which appears not to have been written with any reference to the question of the connexion between apoplexy and diseases of the heart. M. Guillemin details six cases of apoplexy, and in four of these there existed more or less decided hypertrophy of the heart. M. Bricheteau relates§ the particulars of twelve well-marked cases of apoplexy, in which either simple hypertrophy, or hypertrophy with dilatation of the heart, was very conspicuous; but as this writer does not record other cases which had fallen under his notice, and where there was no cardiac disease, it is impossible from such facts to draw any conclusion as to the frequency of the connexion between apoplexy and diseases of the heart.

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* London Medical Gazette, vol. xxii.

† De l'Influence de la Circulation sur les Fonctions Cérebrales: Journ. Complém. des Sciences Méd. vol. iv.

‡ Paris, Juin 1818.

§ Op. cit.

From the above-mentioned sources I have formed the following table, which gives an analysis of 132 cases of apoplexy and sudden hemiplegia with reference to the co-existence of cardiac disease.

AUTHORS.	CASES.	DISEASED HEART.	PER CENT.
Andral	25	15	60·
Clendinning ...	28	15	53·5
Hope	39	27	69·4
Burrows	34	23	67·6
Guillemin... ...	6	4	66·6
Total	132	84	63·6

The inference from the foregoing calculation is, that in any given number of cases of apoplexy and sudden hemiplegia, no less than three-fifths will present unequivocal signs of cardiac disease; either hypertrophy, dilatation, valvular disease, or some combination of these lesions. This proportion proves the frequency is much greater than is commonly supposed, even by those who admit the occasional influence of cardiac disease in the production of apoplexy and hemiplegia.

On the other hand, it is fair to state, that M. Rochoux, in his valuable work*, has come to a different conclusion. After citing the opinions of Corvisart, Bricheteau, Ravier, and Lallemand, in favour of the connexion between apoplexy and hypertrophy of the heart, M. Rochoux states, that out of forty-two cases of apoplexy, which he had examined prior to 1818, three only presented hypertrophy of the heart. In reply to this calculation, I would state, that upon referring to the accounts of thirty cases of apoplexy observed by M. Rochoux, and detailed in his work, it appears that the state of the heart was examined into only fourteen times; and that in four of these serious changes in the muscular or valvular structure of that organ were discovered. Thus, if the simple statement of M. Rochoux be taken, it would appear, that in cases of apoplexy the heart was found hypertrophied in the proportion of 3 : 42, or 1 : 14; whereas if the more correct calculation be made, the proportion of diseased hearts in cases of apoplexy examined by M. Rochoux ascends to 4 : 14.

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* Rochoux, sur l'Apoplexie, p. 424.

Although this average, obtained from the analysis of the cases reported by M. Rochoux, is less than that given in the foregoing table, still it must be borne in mind that lesions of the heart were not so easily appreciated prior to 1818 as at the present time. It is necessary, also, to remark, that this author restricts the term apoplexy* to those cases where there is rupture of the proper tissue of the brain followed by hæmorrhage; and that he excludes from this category those cases described by Abercrombie and others under the title of "simple or congestive apoplexy." To such varieties of the disorder he applies the term "coup de sang," and admits that the state of the heart exerts a very great influence in the production of congestion of the blood-vessels of the brain, although very little upon genuine apoplexy—*i. e.* cerebral hæmorrhage. If this admission be taken into the calculation, it is probable that the average obtained from M. Rochoux's cases would not have materially differed from that given in the table.

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* Op. cit. p. 159 and p. 215.

It has been a subject of discussion which of these several cardiac lesions, viz. hypertrophy of the left ventricle, dilatation of the cavities, or valvular disease, proves the most frequent cause of apoplexy, hemiplegia, and some other cerebral affections.

If we admit the proposition that vascular congestions, extravasations, and effusions, are the lesions which give rise to apoplexies and sudden hemiplegia, then we shall reasonably expect to find in these affections of the encephalon some causes in operation which are known to induce congestions and effusions in other parts of the body.

But what are the usual exciting causes of congestions, hæmorrhages, and serous effusions in different parts of the body? Whatever lesions of the principal viscera are known to be adequate to the production of hæmorrhage or dropsy in the thorax, abdomen, and general cellular tissue, cannot reasonably be excluded from exerting a similar influence within the cranium. Let us first consider the influence of cardiac lesions on the pulmonary circulation. It is now ascertained that hypertrophy of the right ventricle of the heart does not produce pulmonary infiltration and hæmorrhage so readily and frequently as a mechanical obstacle to the passage of the blood through the left side of the heart —a phenomenon which admits of the following easy and rational explanation. When there is an obstacle in the left side of the heart to the return of blood from the lungs, two forces conspire to induce congestion of the pulmonary capillaries and subsequent effusion; the first is the *vis-a-tergo* emanating from the contractions of the right ventricle; the second is, the remora or reflux of the blood in the pulmonary veins from the left cavities of the heart. Now, on the other hand, if there be no obstacle to the circulation in the left side of the heart, there must be an enormous increase in the quantity of blood thrown into the pulmonary capillaries by the right ventricle before a similar congestion and effusion is induced, because there is nothing to obstruct the onward current of blood.

In like manner, it is admitted that general dropsy of the extremities and trunk more speedily and commonly results from valvular diseases and dilatation of the cavities of the heart, which cause obstruction to the venous circulation, than from simple hypertrophy of the left ventricle, however great that may be. In the latter case, as correctly stated by Dr. Hope, serous effusion appears late, is generally moderate in extent, and requires for its production an aggravated form of hypertrophy; but in the former lesions, it appears comparatively early, is more copious, and does not yield with the same facility to remedies.

The same principles may now be applied to the explanation of cerebral congestions, effusions, and extravasations.

Simple hypertrophy of the left ventricle may continue a long time, and it will cause an increased activity in the general circulation; the blood will be thrown into the cranium with more than usual force; there will be a more rapid transit of the blood through the cerebral arteries. But, after a time, this constantly increased force of the left ventricle will have the effect of dilating the cerebral arteries, and thus of overcoming the healthy elasticity of their tunics. Congestion of the cerebral arteries now ensues, and the coats of the dilated vessels no longer protect the surrounding cerebral substance from the inordinate momentum of the blood propelled from the left ventricle. Apoplectic coma is now very likely to ensue from some sudden accidental increase of vascular pressure on the brain. Cerebral hæmorrhage is also likely to occur; for we know, that in advanced periods of life, this hypertrophy of heart is often associated with disease of the coats of the arteries of the brain. This fair induction, founded on acknowledged principles, is fully corroborated by the contents of the preceding table.

Henceforth, hypertrophy of the left ventricle must be admitted as a powerful predisposing, or even exciting cause to apoplexy and sudden hemiplegia.

Let us now trace the effects of some valvular obstruction in the heart upon the brain, and observe how far it is capable of inducing those lesions on which apoplexy and hemiplegia are supposed to depend.

Valvular diseases of the left side of the heart cause, in regular succession, congestion of the pulmonary vessels, of the right cavities of the heart, of the internal jugular and vertebral veins, of the sinuses of the dura mater, and of the whole venous system within the cranium; and if, in this case, the muscular substance of the left ventricle retain its normal thickness and power, and continue to propel the blood with its wonted energy into the cranium, the substance of the brain will then, in all its parts, be placed between the action of two opposing forces—one obstructing the return of blood from the brain, the other continually pouring fresh waves of blood into the cerebral vessels. Under this two-fold force, simultaneously distending the vessels, both veins and arteries, and causing pressure on the surrounding substance, there is no wonder that apoplectic coma should so frequently occur; or that the coats of cerebral arteries already diseased, in advanced periods of life, should yield, or be ruptured, giving rise to effusions of different kinds.

But, in addition to this valvular obstruction, suppose there to be some hypertrophy of the left ventricle, which, indeed, is almost sure to follow sooner or later from any obstacle in the circle through which the blood is constantly moving: why, then, all the effects of valvular obstruction on the cerebral vessels, which I have just enumerated, will be increased in proportion to that hypertrophy. And, should there be any disease of the coats of the cerebral arteries, so common in old age, then will the brain suffer, not only from the pressure of vascular distension, but, *a fortiori*, effusions, either serous or sanguineous, within the cranium, will be the inevitable consequence.

Dr. Watson has pointed out this latter combination of cardiac disease, as peculiarly liable to induce apoplexy, and has expressed his belief that many cases of apoplexy, occurring with cardiac hypertrophy, are dependent, not upon the preternatural strength of the left ventricle, but that the lesion on the left side has produced some corresponding change in the right cavities of the heart, and that the brain is affected by the obstruction to the regular descent of the blood from the head.

From the explanations I have just offered, it is easily understood why hypertrophy of the left ventricle, valvular diseases of the heart, hypertrophy with valvular lesions, or these affections of the heart combined with disease of the cerebral arteries, are, one or the other, so frequently found in fatal cases of apoplexy. The relative frequency of these several cardiac lesions in cases of apoplexy and sudden hemiplegia may be estimated from the following analysis of twenty-five cases recorded by Andral, and thirty-four cases taken from my own case-books.

	NO. OF CASES.	HEART DISEASED.	HYPERTROPHY WITH VALVULAR DISEASE.	HYPERTROPHY (SIMPLE).	VALVULAR DISEASE.
Andral	25	15	9	4	2
Burrows	34	23*	10	6	6
Total	59	38	19	10	8

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* In one case there was simple dilatation of the cavities.

I have thus endeavoured, by facts and arguments, to point out the frequent and intimate relation subsisting between structural changes in the heart and these important cerebral affections. This relation appears to me in many cases to be that of cause and effect.

I have already quoted the opinions of Portal and some others who have entertained a similar view of the pathology of these cerebral affections; but I am not aware that any other author has presented so connected and extended a review of the facts and arguments, which ought to have the effect of establishing a pathological doctrine of great importance in its application to the treatment of these disorders of the brain.

Although I have thus maintained the paramount influence of the heart, both in its healthy and diseased states, upon the circulation and functions of the brain, still I am fully sensible that lesions of other organs, especially of the lungs, kidneys, and liver, have a similar though less frequent and direct influence in disordering the cerebral circulation, and producing apoplexy, hemiplegia, and epilepsy.

In opposition to the opinions entertained by many respectable authorities, that the quantity of blood within the cranium is at all times nearly the same, and that the heart does not influence the cerebral circulation, my own observations, supported by facts already detailed, convince me that in many, perhaps the majority of cases of apoplexy and hemiplegia, the primary disease is not situated within the cranium.

I would go further, and affirm, that in many cerebral affections apparently depending on effusions of serum or blood, there is no further primary disease of the brain than there is of the cellular tissue in anasarca, or of the peritoneum in ascites, or of the skin in purpura, or of the stomach in hæmatemesis. There is, indeed, a palpable morbid condition of these several tissues and organs where the effusion or ecchymosis takes place; but it is generally dependent upon a morbid state of some other viscus, which greatly interferes with the circulation in the parts where the effusions are detected. An hypertrophied left ventricle, or valvular obstruction in the heart, will lead to lesions within the cranium similar to those observed in the stomach and peritoneum, when there is obstruction to the circulation through the portal veins in the liver.

If the pathology of the brain in apoplexy and hemiplegia be analogous to that of other organs which suffer from effusions of serum and blood, how much must this knowledge improve the routine treatment of apoplexy, which has so extensively prevailed.

Does not this view of the pathology of apoplexy render more intelligible those different varieties of the disease, which are described by ancient writers, although they could not account for the differences?

ON THE PERIOD OF LIFE MOST PRONE TO APOPLEXY AND HEMIPLEGIA.

The question to which I shall now seek an answer is closely connected with the preceding inquiry. At what age are individuals most likely to be attacked with apoplexy or hemiplegia?

The information to be found in works on diseases of the brain relating to this collateral part of the history of apoplexy, appears to me vague and ill defined. More correct information on this subsidiary point will throw additional light upon the previous inquiry into the dependence of apoplexy and hemiplegia upon structural changes in the heart. A most remarkable agreement is found among different authors of past times as to the time when apoplexy is likely to occur. The reason for this unanimity is probably to be discovered in this circumstance; that they have all repeated an original observation made by Hippocrates, who affirmed (Aphoris. § 6) that apoplexies chiefly happened between the ages of forty and sixty years. Many subsequent writers repeated this assertion without further inquiry.

Thus Burserius, in his elaborate Institutions of Medicine, fixes the period intervening between the ages of 40 and 60 years as that which is most prone to apoplexy. Dr. Cooke* states, that apoplexy may occur at any age, but it seems most frequently to appear about the middle or in the decline of life. Morgagni has detailed thirty cases of apoplexy: five occurred under the age of 40; eight between the ages of 40 and 60; and seventeen above 60 years of age.

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* Op. cit.

Dr. Bright[*] states it as his impression, that apoplexies occur chiefly above the age of 40, but many above 60 years of age. The majority of authors, according to Dr. Copland, fix the period intervening between 40 and 70 as that in which apoplexy is most common; but it is not, according to that writer, infrequent at both earlier and later periods. Dr. Hope considers the periods of life intervening between 40 and 50, 70 and 80 years, as those during which fatal apoplexy most frequently occurs.[†]

But the calculations on this subject, which are almost invariably referred to in the present day, are those made by M. Rochoux. This physician, as quoted by Andral,[‡] found, in 63 cases of apoplexy attended with extravasation of blood, that

2 occurred between the ages of 20 and 30 years.
8 .... 30 and 40
7 .... 40 and 50
10 .... 50 and 60
23 .... 60 and 70
12 .... 70 and 80
1 .... 80 and 90.

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[*] Medical Reports.

[†] On Diseases of the Heart, &c.

[‡] I have taken the numbers as given by Andral, because his calculations have been usually referred to; but they differ slightly from the original statement in the work of M. Rochoux.

Rochoux remarks,* that although there are more persons living between the ages of 60 and 70, than between 70 and 80, still he does not believe that there are double the number living in the former as in the latter period. So, also, there are more living between the ages of 50 and 60, than between 60 and 70, and yet, from the above calculation, apoplexy appears to be twice as frequent in the latter as in the former ten years of life. Hence Rochoux concludes that the tendency to apoplexy is strongest about the age of 60 years, and that it diminishes both before and after that age.

In reference to this opinion, it must be remembered that M. Rochoux was the physician to the hospital for old men at the Bicêtre when these observations were made; and hence the advanced ages of his apoplectic patients. Rochoux also excludes from his cases of apoplexy, all those whose symptoms arose from simple cerebral congestion (" coups de sang"), independent of hæmorrhage into the brain. If such cases had been included, the numbers at the earlier periods would have been much increased.

Andral† has arrived at a nearly similar conclusion, founded upon these calculations of Rochoux as well as his own. He asserts that apoplexy from cerebral hæmorrhage becomes very common after the age of 50, but that it is observed most frequently in persons from 60 to 70 years of age.

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* Recherches sur l'Apoplexie, p. 418.

† Précis de Pathologie.

I think I shall be able to prove that all the foregoing statements are more or less erroneous; probably because these authors did not regard the relative numbers living at different ages in any given population. Dr. Watson has very correctly remarked on the calculations of M. Rochoux, that in all probability, if the exact truth could be ascertained, of a given number of persons there are more attacked with apoplexy between 70 and 80, than between 60 and 70 years. The correctness of Dr. Watson's surmise will be proved in the following tables, where the relative number of persons living, in successive decades, is compared with the number of apoplexies occurring in the same periods.

It will be found there are only half so many persons living between the ages of 70 and 80, as there are between 60 and 70; and yet the number of apoplexies occurring between the ages of 70 and 80 is more than half those observed between 60 and 70 years.

Pursuing this interesting and useful inquiry, I shall exhibit the relative frequency of apoplexy and hemiplegia at different ages, in a table formed of data collected from approved authors, and from my own experience. The truth is more likely to be obtained from the comparison of cases occurring under the observation of several, than of any one physician.*

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* Some physicians have made their calculations on this subject from private practice; others from experience in hospitals dedicated to the reception of old persons; whilst others have obtained their data from cases met with in our large metropolitan hospitals. The results must necessarily be discordant.

ANALYSIS OF 215 CASES OF APOPLEXY AND HEMIPLEGIA, SHOWING THE PROPORTIONS OF CASES OCCURRING IN THE SUCCESSIVE DECENNIAL PERIODS OF LIFE FROM 20 TO 80 YEARS.

These 215 cases are chiefly selected from the works of well-known authors; the remainder are from my own case-books. Only those cases are included in this table which offered unequivocal symptoms of apoplexy or sudden hemiplegia.

	20 to 30 Years.	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	Above 80	Totals.
Abercrombie*.	3	4	6	7	7	1	0	28
Andral†	3	3	4	6	5	4	0	25
Bright‡	4	4	8	4	5	1	0	26
Rochoux§ . .	2	8	7	10	23	12	1	63
Hope‖	2	2	9	6	7	11	2	39
Burrows¶ . . .	2	9	6	8	7	1	1	34
Totals, in periods of 10 years .	16	30	40	41	54	30	4	215

In the succeeding table there is given a further analysis of the 215 cases of apoplexy and hemiplegia arranged in periods of ten years, and compared with the respective numbers of the population at similar ages; it also shows the proportion occurring in 1000 persons in the successive decades. Population supposed to be 20,000.

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* Op. cit. † Clin. Médicale. ‡ Med. Reports. § Op. cit.
‖ On Diseases of the Heart. ¶ Case Books.

AGE.	NUMBER OF CASES.	POPULATION OF THIS AGE.	PROPORTION OF CASES IN 1000 PERSONS.
20 to 30	16	3,000	5·3
30 to 40	30	2,500	12·0
40 to 50	40	1,800	22·2
50 to 60	41	1,300	31·5
60 to 70	54	1,000	54·0
70 to 80	30	500	60·0
80 and upwards	4	200	
Total ..	215	10,300	

It must be remembered that the figures in the second column of the preceding table do not represent the *actual* numbers of cases of apoplexy and hemiplegia occurring at successive ages in any given population (ex. gr. 20,000), but only the *relative proportion* of cases in each successive decade, and this is compared with the numbers living of the same age. The population is assumed to be 20,000, of whom about one-half will have attained the age of 20 years; and the numbers living in the successive decennial periods will be *nearly* those assigned in the third column of the table*.

We learn from the Report of the Registrar-General, 1843†, that 814 persons died of apoplexy in the metropolitan district during the year 1842. 61 of these persons died under 20 years of age, and which we shall exclude from our present calculations; there will therefore remain 753 deaths from apoplexy, which have been arranged by the Registrar in successive decennial periods.

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* Vide Report of Registrar-General, 1841, page 66. Comparative statement of the ages of persons, supposing (for the sake of comparison) the population to have been 10,000 males and 10,000 females.

† Table, page 472.

AGE.	DEATHS FROM APOPLEXY.
20 to 30	24
30 to 40	67
40 to 50	113
50 to 60	171
60 to 70	185
70 to 80	152
80 and upwards ..	38

In comparing the above with the previous table, we observe the same increase of numbers with increase of age. It must be borne in mind that the relative numbers appear larger in the earlier stages in the former table, and at the later periods in this table, because many cases of apoplexy *occur* at an early, but *terminate* at a much later period of life. The above table refers only to the age at the time of death.

The first general inference from these tables* is, that the relative frequency of apoplexy steadily increases from 20 to 80 years of age; and the second, which is more remarkable, is, that the actual number of apoplectic cases increases in each successive decennial period upwards from 20 to 70 years of age, while the numbers living gradually diminish. The original statistical researches of Dr. Clendinning upon the heart and other viscera, forming the Croonian Lectures for 1838*, will afford some interesting points for further comparison with the results of the previous table.

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* Vide page 131.

This physician ascertained, by a series of extended observations, that the force of nutrition in the heart increases as life advances. This is proved by the increasing average weight of the heart, so that in estimating hypertrophy of the heart some allowance must always be made for the age of the individual. From this writer we learn that hypertrophy of the heart is a change concomitant to that period of life when apoplexy is most prevalent.

Another very remarkable result of Dr. Clendinning's inquiries is, the influence of structural changes in the heart on the bulk and weight of almost all the principal viscera of the body. With these diseases of the heart there appears to be an increase in weight in most other organs, and this applies to the brain as much as to the rest. The average weight of the whole brain in adults, where the heart was healthy, was found to be 50·5 ounces; whereas in diseases of the heart the average weight of the brain was found to be 52·5 ounces. This frequent coincidence of excessive weight of the brain with diseases of the heart is not easily reconciled with any other supposition than that which Dr. Clendinning has adopted; viz. that the augmentation of the encephalon is in some way an effect of the cardiac disease.

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* London Medical Gazette, vol. xxii.

Hence, then, the frequency of apoplexy in advanced periods of life, the usual co-existence of hypertrophy of the heart at the same period, and the ascertained tendency of cardiac disease to produce hypertrophy of the brain, are facts which, when taken in conjunction, confirm the conclusion arrived at in the previous part of the section, namely, that the coincidence between apoplexy and diseases of the heart is something more than accidental.

If diseases of the heart have a tendency to induce hypertrophy of the brain, it is easy to understand the frequency of apoplexy in such individuals. For if cerebral vascular pressure be the common cause of apoplectic coma, then a moderate transitory congestion, or sudden afflux of blood in an already too voluminous brain, may readily produce an apoplectic seizure. It is likewise very obvious that to such persons, if advanced in years, when the cerebral arteries are so frequently diseased, a very moderate vascular congestion may be followed by cerebral hæmorrhage.

But the whole of the preceding inquiry into the pathology of apoplexy and hemiplegia suggests some precautions which may protect those most liable to these diseases from the dangers which threaten them.

It appears that serious changes of structure in the heart are, to a certain extent, almost inseparable from advanced age, and that such lesions peculiarly predispose to apoplexy and hemiplegia. In accordance with these facts, the results obtained from the calculations adduced in this section show that these cerebral affections increase in frequency with advancing years. Hence the soundness of the warning conveyed to mankind in general in the following couplet from Goldsmith—

> "To husband out life's taper at the close,
> And keep the frame from wasting *by repose*."

SECTION V.

OBSERVATIONS ON THE TREATMENT OF APOPLEXY AND HEMIPLEGIA.

The observations which I propose to offer on the treatment of apoplexy and attacks of sudden hemiplegia, will refer to three successive stages in those disorders; first, to the apoplectic coma, or the time of the hemiplegic seizure; secondly, to the stage of cerebral excitement which often appears a few days after the seizure; and thirdly, to the period of paralysis and impaired mental power supervening on the previous conditions.

First, with respect to the remedies to be employed during the continuance of the apoplectic coma, or "fit." Here I have but little to suggest beyond the means usually recommended and employed by the well-informed practitioner. At the same time, I venture to urge the great advantages which may result from a more strict attention than is usually given to the posture of the apoplectic patient, and more especially to the state of the heart, before the question of large abstraction of blood is decided upon.

The remarkable effects of posture in emptying the vessels of the cranium, both external and internal, illustrated by my experiments*, not only warrant the usual practice of raising the head, but should certainly induce us to avail ourselves to the utmost of this method of continued cerebral depletion, particularly in those cases where it is desirable to avoid the abstraction of large quantities of blood. But it is especially in reference to the abstraction of blood in the early stage of all apoplectic and hemiplegic attacks, that the foregoing inquiries into the pathology of those disorders will prove of service. Until within a very recent period, repeated and copious bloodlettings and active purgatives were the principal, if not the only, remedies recommended to be employed in all apoplexies by authors held in the highest esteem. Several, however, of the present day have pointed out many circumstances which would cause such profuse expenditure of the vital fluid in the treatment of apoplexy and hemiplegia to be highly prejudicial. My experience leads me fully to concur in reprobating the indiscriminate use of the lancet in these cerebral affections; and I hope to be able to indicate some conditions of the system which will enable the practitioner to decide for or against large depletion in particular cases, with more confidence than by following the rules which are usually recommended.

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* Plates 1 and 5.

Dr. Abercrombie remarks*, "our remedies are few and simple in the treatment of apoplexy. Those on which our chief reliance is to be placed are large and repeated bloodletting, active purgatives, &c. In the extent of our evacuations, indeed, a due regard is certainly to be had to the age and constitution of the patient, and the strength of the pulse; but I think we have sufficient ground for saying that there are no symptoms which characterise a distinct class of cases requiring any important distinction in the treatment, and which in their nature do not admit of blood-letting."

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* Op. cit. p. 286—8. 3d Edition.

"By bloodletting and other evacuations we cannot, perhaps, properly be said to cure apoplexy; we only relieve the vessels of the brain from the impulse of the general circulation, and thus take off one principal impediment to the recovery, which consists in the vessels resuming their healthy relations after this impediment is removed."

Throughout this author's remarks on the treatment of apoplexy there is not the slightest allusion to the probability of co-existing structural disease of the heart, and to the modifications of treatment such a complication would require.

The principles of treatment in apoplexy recommended by so eminent and experienced a physician as Dr. Abercrombie, have, I doubt not, misled many into the abuse of the lancet. They have been afraid to abstain from bloodletting, since that remedy has been declared to be almost a panacea by this writer.

Several modern writers have alluded to states of the brain simulating congestion of its vessels, and where depletion would only aggravate the symptoms.

Among others, Dr. Holland has ably discussed the question whether depletion is not a practice still too general and indiscriminate in affections of the brain, and especially in the different forms of paralysis? After pointing out many states of diminished nervous power where blood is often injudiciously withdrawn, he states, that even in cases of cerebral disorder where the tendency to coma gave strong presumption of pressure, he has had cause to believe that large bleeding induced paralytic attacks which might otherwise have been spared. This author's valuable remarks on the subject are, however, general, and his object has been to point out broadly the disparity of certain conditions of the brain which have symptoms in common, and where indiscriminate bleeding is often highly injurious.* These principles are equally applicable in the treatment of apoplexy and hemiplegia as in other cerebral disorders.

The state of the pulse in the apoplectic patient has been regarded by some as the symptom which is to guide our judgment in the employment or not of large abstractions of blood. Thus Dr. Copland remarks†, that an intermitting or irregular pulse in a case of apoplexy should cause us to hesitate in the employment of bloodletting; and that when the pulse is small, weak, or quick, the countenance pale, the temperature of the body not increased, or somewhat depressed, bloodletting would be prejudicial.

Dr. Watson has considered‡ these points in the treatment of apoplexy with his usual ability. "If the pulse be full, or hard, or thrilling," he writes, "or if there be obvious external signs of plethora of the head, blood must be abstracted. You are not to refrain from bleeding the apoplectic patient because he is pale, if his pulse warrants it; nor may you omit taking blood if the face be turgid, although the pulse be small, for that smallness may depend on organic disease of the heart. On the contrary, if the skin is pale and cold, and the pulse feeble and flickering, you would probably ensure your patient's death if you withdraw from the failing heart and blood-vessels a portion of their natural stimulus."

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* Medical Notes and Reflections, Chap. iii.

† Dictionary of Medicine, art. Apoplexy.

‡ Lectures, &c. vol. i. p. 521.

It may appear almost superfluous to add anything to these judicious remarks upon the state of the pulse, the pallor or turgescence of the face, and the temperature of the surface, as indications for or against the abstraction of blood in apoplexy. But the result of the inquiries I have made into the pathology of apoplexy, and which I have detailed, leads me to suggest another imperative precaution before we absolutely determine for or against the abstraction of blood by the lancet, or in any other way, in a case of apoplexy or hemiplegia. The precaution I would recommend as an invariable rule is, that before the treatment of any case of apoplexy or hemiplegia is commenced, the state of the heart should be as carefully inquired into as the characters of the pulse, the respiration, or any other indications for and against the abstraction of blood. The information thus obtained will very often assist the practitioner, and add much to the interest of the case. The peculiarities of the pulse in apoplexy and other cerebral affections must, indeed, be noticed, but they are often very perplexing, especially when we are looking to the state of the circulation as an indication for treatment. It will be found that, upon a careful examination by auscultation into the state of the heart in such cases, much of this difficulty will be removed. Indeed, now that we know how materially the circulation in the brain is influenced by the various lesions of the heart, it would be a culpable neglect not to investigate this point.

If no cardiac disease be discovered, or if simple hypertrophy without notable valvular disease be detected, depletion, both general and local, may be carried on so far as the cerebral symptoms appear to call for that kind of relief.

Perhaps the class of apoplectic attacks requiring large loss of blood are less common now than they were half a century ago; partly on account of the more temperate habits of the present generation, and partly because the custom of retiring to rest shortly after a full supper, with a due proportion of stimulants, has been abandoned.

But suppose a careful examination of the apoplectic or hemiplegic patient's heart discloses the existence of valvular disease to the extent of obstructing the circulation through its cavities, here the pulse will be a most deceptive guide as to the propriety or impropriety of abstraction of blood. If the mitral valve be principally implicated, and allow of regurgitation from the left ventricle, the small and irregular pulse so commonly observed with that lesion would probably dissuade from that free abstraction of blood which the cerebral symptoms might require. If, in another case of apoplexy or hemiplegia, the aortic valves be found diseased to the extent of not only obstructing the onward current of blood, but also of allowing regurgitation into the ventricles, during its diastole there will probably be associated with this lesion considerable hypertrophy of the left ventricle. Here will be observed a full and vibrating or thrilling pulse, but a pulse of increased action without real power, and hence a deceptive pulse; and one which, if it be regarded without reference to the structural changes of the heart, would invite to a more copious abstraction of blood than was called for by the general symptoms. In each of these last-mentioned cases greater relief to the symptoms will be obtained by a free local abstraction of blood from the vicinity of the heart (either by cupping from beneath the left mamma, or between the left scapula and spine) than by a much larger depletion by venesection.

Again, there are other instances of apoplexy and hemiplegia, where, from an examination of the heart by auscultation, we feel assured there is serious valvular disease; and, from the character of the cardiac murmurs and other physical signs, we arrive at a well-grounded suspicion that there is osseous deposit about the valves of the left ventricle, in the coats of the ascending aorta, and, in all probability, in the tunics of the arteries within the cranium. In such a condition of the arterial system an accidental cerebral congestion may have been followed by extravasation of blood, and thus have arisen the most common symptoms of apoplexy. The knowledge obtained through auscultation in such cases would properly dissuade from large losses of blood, although the fulness and hardness of the radial pulse might at first have invited such depletion.

There are other cases of apoplexy and hemiplegia, where we discover dilatation of the cavities of the heart and extensive emphysema of the lungs; the latter lesion is, indeed, a more common cause of cerebral congestions and hemiplegia among the labouring classes than is commonly supposed. In such cases the appearances of extreme congestion and dyspnœa might tempt to practise large depletion, and thus the very conditions of the heart which have induced the cerebral congestion and apoplectic symptoms would be aggravated. I should here suggest the employment of the cupping-glasses to the nape of the neck, or between the scapulæ, with the internal administration of stimulating diuretics, diffusible stimulants, and the application of rubefacients to the sternum*. Many mistakes arising from the causes I have now adverted to may certainly be obviated if a careful examination of the heart and lungs be made with the stethoscope in the first or congestive stage of apoplexy, or immediately after an attack of hemiplegia.

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* It is a popular belief that persons with a peculiar conformation of the body, namely, with large heads, red faces, short necks, and capacious chests, are predisposed to apoplexy; and that persons of spare habit with longer necks are exempt from that disease: so that if a person of this latter description is attacked with apoplexy or hemiplegia, considerable surprise is expressed. My experience causes me to doubt the accuracy of these opinions. The former class of individuals are usually the subjects of considerable hypertrophy of the heart, and hence suffer from habitual determination of blood to the brain, and perhaps hypertrophy of that organ. No wonder that they should suffer from attacks of apoplexy. But I have met with many instances of apoplexy and hemiplegia among the poor where the individuals have been pallid and attenuated, with slight figures; in fact, presenting the very reverse to the so-called apoplectic make; and in such cases, upon making a careful scrutiny of the heart and lungs, I have discovered signs of valvular diseases in the heart, or perhaps of extensive emphysema of the lungs, and these diseases probably combined with changes in the arterial coats.

Secondly, on the treatment of apoplexy or sudden hemiplegia during the stage of cerebral excitement supervening soon after the seizure. My remarks will here apply principally, but not exclusively, to that form of apoplexy which is followed by hemiplegia, and where there is, therefore, reason to suspect extravasation of blood into one of the hemispheres of the cerebrum or cerebellum.

Our improved knowledge of the morbid anatomy of the brain, and particularly of the changes which take place in and around a clot of blood after it has been extravasated into that organ, ought to materially influence the principles of treatment in the stage of cerebral excitement after apoplexy. I shall not stop to describe these changes in blood extravasated within the cranium; they are detailed at length in the "Anatomie Pathologique" of Andral, and in other modern works on morbid anatomy, and are very faithfully and beautifully delineated in Dr. R. Bright's Medical Reports.

In cases of apoplexy, about two or three days after emergence from the coma, and recovery from the depletion practised during "the fit," we often observe the patient's face to become flushed, the scalp hot, a frowning or knitting of the brows, slight strabismus, and complaint of pain on one side of the head. This pain is usually referred to the temporal, parietal, or occipital region opposite to the paralysed limbs; and if the patient be deprived of the power of expressing his sensations, his uneasiness is often indicated by the occasional movement of the sound hand to the forehead: at the same time, the paralysed arm is perhaps observed to be occasionally drawn up to the face, or across the chest. This latter movement taking place after the fit, gives rise to the hope that the hemiplegia is not so complete as it was at first supposed to be; but, in truth, such movements of the palsied limb are often altogether deceptive. They are involuntary, and arise, as I believe, from commencing irritation in the nervous matter of the brain immediately around the extravasated blood. At the same time, the circulation, which had been much enfeebled by the remedies employed during the fit, becomes more active; the patient is thirsty, and is sometimes troubled with an oppressive heat of the surface of the body.

These symptoms, which are indicative of inflammatory action* commencing around the clot of blood in the brain, may generally be controlled in a most striking manner by small local depletion from the temple or mastoid process on the side opposite to the paralysis; by the application of cold to the head, and by the administration of purgatives, by restricted diet, and by extreme quiet in the sick-room. In addition to these remedies, I have found, when the heat of head is diminished, that a blister applied near the occiput affords great relief to the oppressive headache. If the patient be not very advanced in years, or extremely exhausted by depletion, great benefit will be derived at this stage of apoplexy from the administration of small doses of mercury. One grain of calomel may be given every six hours, leaving the mineral to act as a purgative, or to slightly affect the gums, but not allowing the mercury to produce ptyalism, which is generally very distressing to the hemiplegic patient, whose powers of mastication and deglutition are already impaired by his disease.

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* Our suspicions are often confirmed by the state of the blood drawn under the above-described circumstances. While the blood drawn at first from apoplectic patients does not offer any uniform or remarkable appearances, it will, at this subsequent stage, be frequently covered with a buffy coat.

Simultaneously with the above-described train of symptoms, or soon after their appearance, the paralysed limbs are not uncommonly affected with involuntary movements, which usually consist of spasmodic contractions, either tonic or clonic. The patient will now most probably complain of severe pains in the palsied limbs, of burning heat in them, so that he will long to plunge them into cold water: the integuments of these limbs often feel hot, and are red and swollen.

It is difficult to say upon what these pains in the paralysed limbs depend, but they often constitute a most striking feature in the after-progress of a case of apoplexy or hemiplegia. At each visit of the medical attendant the patient piteously demands something to alleviate his sufferings, which greatly interfere with his night's rest. These wearing pains are not confined to the integuments, but appear to pervade the deeper-seated parts, so that the periosteum of the bone of a palsied limb will become swollen and painful. In some cases these pains have appeared to be attributable to the continuance of irritation from the clot upon the surrounding cerebral substance; in other cases there has been no evidence of cerebral excitement; but this painful state of the limbs seemed to depend upon returning functions in the nerves, and partly upon the capillary circulation in the tissues of the limb not being duly regulated by the nervous system. These pains in palsied limbs are very analogous to those which are experienced in a part when the circulation and animal temperature are returning to it after it has been benumbed by cold.

I have tried numerous local remedies in the hope of subduing these harassing pains, but without corresponding success. Cold evaporating lotions, warm fomentations, anodyne fomentations, lotions and embrocations, and stimulating liniments, have produced but little more than temporary relief. The remedies which I have found most serviceable have been slight local depletion from the head, when there has been any remaining symptom of cerebral irritation, combined with the application of evaporating lotions, either tepid or cold, to the affected limbs. Where headache, flushing, heat of scalp, and other similar symptoms, have been altogether absent, I have found, in a few cases, marked relief to follow the application of leeches to the painful limb, together with evaporating lotions or poultices. It will sometimes happen that the redness and heat, which have been present in the palsied limbs when the pains commenced, will subside, but the neuralgia remains. These cases are very distressing to witness, on account of the constant suffering which we cannot remove; nevertheless, after the lapse of some time—weeks or months in different cases, the pains gradually disappear. A change in the condition of the soft parts of the paralysed limbs now succeeds; they shrivel and waste away; the limb becomes more or less contracted in different cases; any attempt at extension causes much pain; the limb loses its temperature readily, if exposed uncovered to the atmosphere, and when confined in bed it is often found bedewed with a warm clammy perspiration. There is very little hope of any restoration of muscular power when such changes have taken place; but much may be done to prevent such limbs getting worse; and this treatment I shall describe in the following division of my present subject.

Thirdly, On the treatment in the stage of paralysis following apoplexy.

It sometimes happens, when persons have been attacked with apoplexy, which has been slight, or from which, under active treatment, they rapidly recover, although still more or less palsied, that they become anxious to rise from bed, and enjoy more freedom in exercise, mental occupation, and diet, than is usually allowed after such attacks. In other cases the urgency of the patient's affairs, or the natural activity of his disposition, tempts him to resume mental occupation at a very early stage of his convalescence. Should the medical attendant yield to these wishes of his patient, and permit such latitude, both parties will have cause to regret the imprudence, for serious consequences are not unlikely to ensue. The cause of such bad effects is readily understood by those who are familiar with the morbid anatomy of the brain after apoplexy.

One of three accidents may happen. First, if there be too early excitement of the cerebral circulation after the fit, and before the fluid parts of the extravasated blood are absorbed, and while the cerebral substance around is still soft from infiltration, and before a cyst is formed around the clot, a fresh extravasation will take place, and produce irreparable mischief.

A second accident likely to ensue from too early exertion after apoplexy, followed or not by palsy, is a renewal of the head symptoms, and subsequent disorganization of the cerebral substance.

A third serious consequence of a too early return to mental occupation, or the anxieties of business, is the supervention of inflammation of the brain and its membranes.

I shall recite a few cases in illustration of these accidents, which, when they happen, so seriously interfere with the satisfactory progress to convalescence from apoplexy.

CASE I.—*Fatal Cerebral Hæmorrhage, probably occasioned by too early Exertion during Recovery from a former Attack of Apoplexy.*

A middle-aged woman was admitted into St. Bartholomew's Hospital under my care, having suffered from an apoplectic fit a few days previously, which had left her hemiplegic. No unfavourable symptoms were observed at the time of her admission. She was kept quiet in bed, and purgatives were administered. Her convalescence progressed steadily, and she rapidly regained power in the leg, and partially in the arm. At the end of a fortnight I one day found her dressed, and sitting up by the side of her bed, and as she appeared comfortable I was unwilling to order her to return to her bed. A few days afterwards this woman dropped down in the ward quite insensible, and died in the course of a few hours. Upon examination of the head, there was discovered an extravasation of blood into the corpus striatum, which, from its appearance, was probably coeval with the former apoplectic seizure. In addition to this lesion, a quantity of bloody fluid was found in the lateral ventricle. This fluid had evidently escaped by a rupture of the walls of the cyst in the corpus striatum, which contained the original extravasation. The aperture of communication is well portrayed in a drawing preserved in the Museum of St. Bartholomew's Hospital, and had probably been formed by laceration of the softened cerebral substance around the clot of blood at the time of the second and fatal seizure. If a longer period had elapsed after the first seizure, before this woman had begun to exert herself, I think she probably might have escaped the second attack which terminated fatally.

CASE II.—*Rapid Recovery from Apoplexy, succeeded by Chronic Disorganisation of the Brain, probably augmented by too early Exertion after the Fit.*

In November, 1843, I was requested to visit a lady from the country, concerning whose case I learnt the following particulars:—Her age was 54, and she had had thirteen children. She was of a spare, delicate frame up to the age of 46 years, when the catamenia ceased, and she became stouter and stronger. In the spring of 1843, whilst walking in the street, she was taken with vertigo, and nearly lost her consciousness; her face was flushed, and her pulse strong at that time. She was not bled, on account of some objections on the part of her friends. About three months afterwards, when very stout, she had another attack, which was more decidedly apoplectic, and which was followed by hemiplegia of the left side. After this seizure there was so much collapse that no blood was drawn, and under the use of purgatives and abstemious diet she slowly recovered, her paralysis entirely disappearing. A few days before I saw her she had arrived in London, with the intention of paying visits to some friends. On the morning of my first attendance, whilst dressing for breakfast, she fell down 'quite insensible, but recovered after half an hour so far as to be able to pull the bell-rope, and get towards her bed.

At 4 o' clock, P.M., her countenance looked heavy, but there was no paralysis of any part; she complained of intense oppressive headache, which she said was of some days' duration; the tongue was furred; the pulse 84, small, compressed, and hard; thirst troublesome. The heart's impulse was much greater than natural,—so much so as to heave up the head when resting on the stethoscope applied to the cardiac region; the systolic sound was not healthy, but without a distinct murmur; the second sound of the heart was clear. She made no complaint of palpitation, but when her attention was drawn to the state of her heart, she said she had occasionally experienced a sensation of stifling at the heart, which she had been told was faintness.

She was ordered to lose ten ounces of blood by cupping from the nape of the neck, and to take Hydrarg. Chlor. gr. v. in the evening, and a Senna draught on the following morning.

The loss of blood gave her immense relief; she slept well; the headache had greatly subsided on the following day; the pulse 92, still small, and rather hard; the tongue clean, and the bowels freely open. Auscultation the same.

She was ordered—

℞—Hydrarg. Chlor. gr. iij.
Pil. Rhei Comp. gr. vj.
Ft. pil. ij. hâc nocte sumendæ.

℞—Tinct. Digitalis ♏ xv.
Potassæ Nitratis gr. x.
Potassæ Carb. ℈ j.
Aquæ Destil. ℥iss.
Ft. haustus, 6ta quâque horâ sum. cum cochleari uno amplo succi limonis.

In the course of two more days, this lady had improved so much, that she and her friends were most anxious that she should return home, which was about eight miles distant from London. To this I consented, as I knew she would have the benefit of close watching from a medical friend, her near relative.

Within a few days of her return, she was seized with a recurrence of pain in the head; she became feverish, restless, with distressing sickness, and feeling of weakness. These symptoms were met by the application of leeches to the head, and by the use of purgatives and effervescing saline draughts. On the tenth day of her removal from London, I was sent for to see her in the country. I found her exhausted from want of sleep, restlessness, and continual retching. The headache had subsided; she was thirsty, tossing her arms to and fro; her mind was clear; the pulse 84, sharp, with some power; she had recently taken nourishment; the skin warm; the tongue furred, but moist; severe pain in the abdomen, with dark slimy stools. The heart's action was greater than natural, the systole being accompanied with a murmur of a musical character.

The history of this lady, from the recent apoplectic seizure up to the date of my visit, and the symptoms then present, led me to form the opinion that she was suffering from some change going forward in the substance of the brain, consequent on the apoplexy; and that this morbid action had been increased by too much exertion after the recent attack. I also supposed the muscular tissue of the left ventricle of the heart was hypertrophied. I prescribed a grain of calomel to be taken every six hours, an occasional effervescing draught of citrate of ammonia, with slight excess of the alkali, and the application of blisters from time to time. The nourishment to be light, and diffusible stimulants to be administered if the exhaustion continued.

Upon this plan of treatment the case proceeded favourably during the ensuing month, so that she was able to be removed from her bed to the sofa daily: the sickness and headache subsided. The musical murmur was only occasionally heard with the systole of the heart.

In February, 1844, I learnt that this lady had not made further progress in her convalescence; that she remained weak and emaciated; the headache and irritability of the stomach being very oppressive: the heart's action continued greater than natural, but the murmur was not always audible. She lingered on to the month of April, suffering from the above described symptoms; the heart's action remaining excessive, and its systolic murmur nearly constant.

Upon examination post mortem, all the arteries of the brain were found more or less ossified, so that they could be drawn out of the cerebral substance like so many rigid wires; the substance of the brain appeared atrophied, and infiltrated with serum; the medullary pulp was also somewhat softened.

The heart was natural in size, with slight hypertrophy of the left ventricle; the tendons of the mitral valve were thickened and shortened.* There was nothing remarkable in the lungs.

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* The state of the heart in this case supports the opinion, that these systolic musical murmurs are rather the result of rapid vibrations of the muscular fibres of the heart, during excited action of that organ, than of any peculiar change of structure in the valves.

CASE III.—*Apoplexy followed by repeated attacks of Cerebral Excitement, probably induced by Imprudent Exertions.*

In the autumn of 1844, I was requested to visit a highly respectable Somersetshire farmer, who was under the care of Mr. Gayleard, of Beaumont-street. He was a robust, well-formed man, about 56 years of age, and of temperate habits. About three months previously he had been seized with a fit, and lost his consciousness for a quarter of an hour. He was bled from the arm, and recovered both speech and power of voluntary motion. Soon after this event he became restless, and was taken from home to the neighbourhood of Portsmouth for change of scene. While resident there, about sixteen days before I first saw him, he had another fit, lost his consciousness, and remained stupid for three or four days. He then became restless, and was allowed to get up and go about, although he was weak, and not clear in his mind. Eight days after this second fit, he was brought up to London, by railway, and within a few days after his arrival in town became so excited and uncontrollable, that his medical attendant thought it prudent to put him under restraint. His friends were now anxious to remove him to his home in Somersetshire, but were advised to have a physician's opinion upon his case prior to his journey.

I found this patient, early in the day, supported on a sofa, drowsy, breathing laboriously, with puffing of the cheeks and lips during expiration: the face was rather drawn to the left side. He was easily roused; the pupils were much contracted; he had some difficulty in protruding the tongue, and the right angle of the mouth was motionless; the power of the right arm and leg was much impaired, so that he could not sustain the weight of the arm, nor stand alone; his urine had passed involuntarily two or three times; and his alvine evacuations also, but only after the action of a purgative. When asked if he had headache, he replied, "Yes, sir;" and to other questions he answered in monosyllables. The pulse 100, and weak; the heart's sounds were loud, and heard over an extended space; the tongue furred; the bowels had been costive, but were now freely open by the use of purgatives. I felt it my duty to explain to the relatives that the symptoms in this case had been materially aggravated by the too hasty removal of the patient by railroad from Portsmouth to London, so soon after his apoplectic seizure; and that, if they persisted in their intention of removing him forthwith into Somersetshire, they would incur the risk of bringing on another apoplectic attack, or some other serious cerebral affection. By my advice, he was therefore kept quiet in his apartments. Blisters were applied behind the ears, one grain of calomel was administered every six hours, and a diuretic draught given three times daily.

At the expiration of four days his aspect had much improved; the application of the blisters had been followed by marked symptoms of amendment; the pupils were still contracted, the paralysis of the face had disappeared, and the limbs had recovered much power. He answered correctly to short questions, but his mind soon wandered, as he continued to talk almost incoherently after he had been spoken to. The pulse 70, soft; the tongue cleaner; the bowels open, and urine free; he had recovered command over the sphincters. A blister was applied to the nape of the neck; the other remedies were continued as before.

After another period of four days, his appearance and manners were more natural; he answered more correctly, and wandered less; he was able, with assistance, to play a game at cribbage; he was capable of directing his son to write home about farming business; there was no perceptible palsy; he had taken a short walk out of doors; the pulse 70; sleep natural; the tongue clean; the bowels open.

Blisters were again applied behind the ears, and the calomel was given only at night and at morning.

In four days more from this time, I found my patient still further improved; the gums were now slightly affected by mercury; all the bodily functions were regular; he was more conscious, and had less difficulty in expressing himself, but his mind occasionally wandered, if he attempted to converse; he made me understand he wished to go home, on account of the expenses of London, and in this idea he was unfortunately encouraged by his wife.

I explained to this patient's relatives the advantages that would result to him from quiet, and a continuance of the medical treatment; but this advice they did not appear capable of appreciating, for they removed him into the country a few days afterwards.

In January, 1845, I had an opportunity of learning from Mr. Gayleard, that this patient had travelled to Bristol, by railroad, a few days after my last visit. He became excited and confused immediately upon his arrival at home. A surgeon was sent for, who thought it necessary to bleed him to twenty ounces, and to employ other active remedies. The further history of the case I have not obtained.

I consider this to be one of a class of cases where the symptoms consequent upon the apoplectic fit had been materially aggravated through the imprudent excitement of the system (by exercise and railway travelling), at a time when the cerebral circulation should have been kept in tranquillity, and an opportunity afforded to the brain to have recovered from the shock it had experienced at the time of the fit.

The following case is so apposite and instructive, that I shall offer no apology for quoting it:—

Dr. Watson states*, that on a 3d of September, he received a note, written in a clear and neat hand, desiring that he would call upon the writer, as he had had a severe attack of apoplexy a day or two before.

Dr. Watson concluded that the note had been penned by some member of the patient's family, and he expected to see him in bed, paralytic probably, or manifestly ill. The patient proved to be a stout active gentleman, who was walking about his drawing-room, apparently in perfect health, and declaring that he felt so. He showed Dr. Watson, however, a paper written by a surgeon who, on the previous day, had brought this patient to town from a distance, and who had been obliged to return home immediately. The paper stated that Mr. —— had suffered a sudden and decided fit of apoplexy on the 30th of August; that he was then freely bled; that perfect consciousness was not restored, nor the force of the pulse subdued, till twenty ounces of blood had issued from his arm; and that on the evening of the same day sixteen ounces more were drawn.

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* Op. cit. p. 498: 1st Edition.

Dr. Watson thus continues the narrative of the case:—

"My patient spoke of going down to his country-house, where he had, he said, 'a good deal of shooting to do.' I dissuaded him from this, and enjoined perfect quiet for at least a fortnight to come.

"The next day, after a long and imprudent conversation with a friend, he suddenly lost the thread of his discourse, and could not recover it. Then he became confused, and misapplied words. I asked him how he felt. He answered, 'Not quite right:' and this he repeated very many times, abbreviating it first into 'not right,' and at length into 'n' ight.' Wishing to mention 'camphor,' he called it 'pamphlet.' On the 5th it was evident that his right arm and leg were weak in comparison with the others; but their sensibility was unimpaired. By slow degrees he became hemiplegic. Gradually, also, he became heavy, stupid, comatose, unable to swallow, with a fixed pupil; and so, on the morning of the 15th of September, he died.

"The head was examined the next day. On the left side the dura mater adhered to the skull-cap with morbid firmness. During the endeavour to detach it a table-spoonful or more of a dirty-looking, greenish, offensive pus spurted forth. This was found to have proceeded from an abscess, which must have contained two ounces of pus, and which was situated in the upper part of the left hemisphere of the cerebrum. The walls of the abscess looked as if they were coated with a layer of yellowish plaster. In the centre of this cavity was a small, fibrous, tough mass, of a dull red colour —the coagulum, doubtless, of the blood effused on the 30th of August. In front of the abscess the brain seemed natural, but its consistence was that of liquid custard."

The foregoing case affords a good example of the third serious consequence—viz. inflammation of the brain—likely to arise from a premature return to mental occupation or active pursuits after an attack of apoplexy.

Many cases similar to the foregoing have, no doubt, occurred in the practice of others; they forcibly illustrate the great dangers which result from exciting the cerebral circulation too soon after an attack of apoplexy, and before the processes of reparation are completed around the extravasated blood.

When sufficient time has elapsed from the fit to allow of a restoration of the injured cerebral substance to its healthy condition, it becomes of importance to excite the suspended functions of the nerves in the paralysed limbs. To effect this object, the application of blisters or frictions with stimulating liniments over the affected limbs, particularly in the course of the great nervous trunks, are sometimes attended with good results. Such measures, if not directly beneficial to the palsied limbs, sustain the confidence and hopes of the patient during his tedious convalescence.

At this period it is necessary to consider whether more direct stimulants to the nerves should not be employed, and, if this question be determined in the affirmative, perhaps electricity is the most appropriate stimulus. The most convenient mode of applying the stimulus is with an electro-galvanic machine, by which a continuous current may be passed through the affected limbs.*

The conditions most favourable for the use of this remedy are, where there is a total absence of headache, or other cerebral symptoms, and where the patient's mind remains firm, and without alarm at the ordinary effects of the electrical current. If its use be resorted to under circumstances the reverse of the foregoing, or its application cause much pain in the paralysed limbs, it certainly does no good; often much harm. But even under the most favourable circumstances, when hemiplegic patients come to St. Bartholomew's Hospital for the express purpose of having their palsied limbs electrified, I cannot say that I have witnessed any decided benefit from the remedy. In paraplegia, on the other hand, the good effects are often unquestionable.

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* Mr. E. Shaw, late Assistant-Apothecary of St. Bartholomew's Hospital, who had considerable experience in the application of electricity in the treatment of paralysis and other diseases, gives the following account of the apparatus he employed. "It consists of a double coil of wire on a cylinder, the ends of one coil connected with a single cell battery on Smee's principle (with amalgamized zinc and platinized silver), and the ends of the other connected with the directors to be applied to the patient. As a means of making and breaking contact, I have attached to the above a small horse-shoe magnet, with a bar of soft iron, round which is twisted a coil of copper wire, the ends dipping into a cup of mercury: this bar, working on a pivot between the poles of the magnet, acquires the polarity of each in turn, and being therefore repelled, a constant revolution is kept up."—(Medical Remembrancer, &c. 2d Edition, by E. B. Shaw, M.R.C.S. p. 81.)

My opinion as to the effects of strychnia as a direct stimulus to the nerves in hemiplegia is even less favourable than that which I have expressed respecting electricity. In some cases strychnia does much harm, by aggravating the wearing pains in the affected limbs to a much more acute suffering.

Another safer and more beneficial mode of exciting the nerves of palsied limbs, is by regular frictions over their surface, and by well-devised exercise of the muscles. Such methods excite a more active circulation in the wasted muscles and nerves of the limbs, by which the peculiar functions of their respective tissues are renovated and invigorated.

It is a very common practice to institute some permanent counter-irritation at this stage of hemiplegia, either by a seton or issue at the nape of the neck. This is generally done with the hope of warding off another apoplectic seizure. The efficacy of such a measure will greatly depend upon the exciting cause of the cerebral congestion which produces the apoplectic coma. If there be some idiopathic affection of the encephalon, then such permanent means of counter-irritation may retard the unfavourable progress of the disease; but if, on the other hand, the cerebral congestion is attributable to some of those serious lesions of the heart alluded to in the foregoing sections, then I consider counter-irritation at such a distance from the affected organ not only useless, but sometimes positively injurious.

SECTION VI.

ON THE INFLUENCE OF DISEASES OF THE HEART IN EXCITING FUNCTIONAL DISTURBANCE OF THE BRAIN.

The influence of structural diseases of the heart upon the brain is not confined to the production of apoplexies and attacks of hemiplegia; but many other disorders, which are characterised by a variety of symptoms indicative of disturbance of the circulation in the head, will, I believe, be found to be dependent upon, or seriously aggravated by, chronic cardiac diseases. Recurring attacks of vertigo, headaches, rushing of blood to the head, of epistaxis, somnolency, nervous irritability, and even insanity, may often be traced to the operation of cardiac disease, which has not attracted the notice of the patient or his medical attendant. Although I shall not, upon the present occasion, support these statements by any array of numerous cases, still I shall proceed to point out some of those head affections where such a complication often exists.

First, I would particularly invite attention to the state of the heart in severe cases of Epistaxis occurring in adults of middle age, who have not habitually suffered from that discharge. It will be found that this hæmorrhage may often be traced to the disturbed circulation produced by structural changes in the heart; either by hypertrophy or valvular obstructions, and especially by disease of the mitral or aortic valves.

I shall proceed, without further preface, to relate a few cases of *epistaxis* complicated with cardiac disease, and to subjoin some practical remarks upon them.

Case I.—In the month of February 1840, I was called to visit a lady, aged about 46 years, of florid complexion, the mother of a large family, and who had recently suffered from two attacks of profuse epistaxis, which had occasioned great exhaustion. The hæmorrhage had, upon the last occasion, been successfully controlled by Mr. Bacot, of Portugal Street, who had effectually plugged the nostrils, and prescribed styptics. She complained of debility, dyspnœa, and a feeling of constriction across the chest; the pulse was 100, small and sharp; the carotids were throbbing, and there was occasional palpitation of the heart. Upon auscultation in the cardiac region, a great impulse, with an occasional bounding of the heart, was perceptible, as well as a loud prolonged systolic murmur.

I learnt that the catamenia had formerly been profuse, but were now not so abundant; and that some years ago, when suffering from menorrhagia, she had been advised to sit in cold water every day. An imprudent use of this remedy brought on severe rheumatic fever; and she remembers to have suffered from palpitation of the heart occasionally ever since that attack.

It was nearly certain that this lady was suffering from hypertrophy of the heart, with disease of the mitral valve, and perhaps some adhesions of the pericardium consequent upon former rheumatic inflammation of the heart. It was my opinion that, as the vascular system did not now obtain the usual free relief through menorrhagia, and as the gradually increasing morbid changes in the heart interfered with the uniform transit of the augmented quantity of circulating fluid, a congestion of the vessels of the cranium had been the result, and this had relieved itself by the profuse epistaxis.

An occasional small abstraction of blood from the region of the heart was resorted to, and diuretics were administered. The epistaxis did not reappear for two months, when it recurred to a slighter extent.

About this stage of her illness she was, upon three or four occasions, seized with a peculiar spasmodic action of the muscles of the upper part of the body as well as of the limbs. Her mind also wandered. These symptoms yielded to the influence of morphia and counter-irritation.

At length anasarca of the lower extremities commenced, which was soon followed by ascites; there was no further epistaxis, and the patient died from general dropsy July 1840.

The dropsical symptoms, in the foregoing case, most probably resulted from a general venous congestion produced by the same obstruction to the circulation through the heart which, at an earlier stage of the case, had given rise to the hæmorrhage from the nostrils.

An alternation between hæmorrhage and serous effusion is by no means an uncommon occurrence in the advanced stages of valvular diseases of the heart. Whether the hæmorrhage and serous effusion shall take place from the same set of vessels, depends upon many accidental circumstances; with respect to the part of the body where the congested vessels shall relieve themselves in any particular case, this will depend, partly on the idiosyncrasy of the individual, partly on the time of life, and partly upon structural changes in different organs resulting from previous diseases.

Case II.—John B——, æt 21 years, was admitted, June 17th, 1843, under my care, into St. Bartholomew's Hospital, suffering from the most profuse epistaxis. The nostrils had been plugged before my visit to the ward, but the hæmorrhage still continued. The man was pallid, faint, and giddy; the conjunctiva bloodless, and the skin profusely perspiring; the pulse 120, very *thrilling* (by which term I mean "bounding without power"); the heart's impulse was great; the carotids and even the smaller vessels pulsated violently.

The apex of the heart appeared to beat in the sixth intercostal space, about one inch to the left of the nipple; there was extended dulness on percussion in the cardiac region; the cartilages of the left ribs were much more convex than those on the right side. Upon auscultation a loud systolic murmur was audible at the apex; a double murmur was heard at the base and up the sternum, and a loud systolic murmur in the carotid, brachial, and radial arteries.

This man informed me that he had been a servant, and of temperate habits; that six years since he had suffered a severe attack of rheumatic fever, for which he was admitted as a patient into St. Thomas's Hospital, and where he was twice cupped from the cardiac region. Since that illness he had been unequal to much exertion, as it produced violent palpitations. He had experienced several subsequent returns of the rheumatism.

The physical signs detected in the cardiac region led us to the conclusion that this man had been the subject of most extensive rheumatic endocarditis and pericarditis, which had terminated in serious changes of the mitral and aortic valves, allowing of regurgitation at both orifices. We also suspected the heart was hypertrophied and the pericardium adherent.

The present epistaxis came on at 5 o'clock on the morning of his admission to the hospital, and whilst he was in bed. His heart had been palpitating much previous to the bleeding, in consequence of over-exertion on the day before. He had had a violent attack of epistaxis three years ago, and slighter returns of the complaint in the interval.

The recurring epistaxis in this case was, in my opinion, the result of a determination of blood to the vessels of the head, induced by the over-action of an hypertrophied heart. Had this patient been twenty years older, when the vascularity of the Schneiderian membrane had become less rich, and the vessels within the cranium had undergone changes from progressive disease of the vascular system, he would probably have been attacked with apoplexy accompanied with extravasation of blood within the cranium. His youth, and the ready escape of blood from a mucous membrane, saved him from this latter accident.

The epistaxis was controlled by keeping the patient in the sitting posture, with cold applied to the head, and plugs in the nostrils. He also took two grains of the Acetate of Lead, with a quarter of a grain of Opium, every six hours, and a draught containing the Liquor Ammoniæ Acetatis, Tincture of Digitalis, and Nitrate of Potash, every four hours.

At the expiration of twenty-four hours from the commencement of the epistaxis, and of sixteen hours from the time of his admission to the hospital, the bleeding ceased, and did not return during the ensuing three weeks he remained in the hospital. The cardiac symptoms were relieved, but not essentially altered, at the date of his discharge.

Case III.—John H——, æt. 19 years, was admitted under my care into St. Bartholomew's Hospital, on May 16th, 1842. His countenance was pallid, and the conjunctiva bloodless. He complained of dyspnœa, pain in the præcordia, of cough with sputa tinged with blood, and of anasarca of the lower extremities. The respirations were 40, and the pulse 104, thrilling under the finger. The heart's impulse was increased, and its action tumultuous, the apex striking the chest between the fifth and sixth left ribs, two inches below and to the left of the nipple; its pulsations were visible in the epigastrium, and over a great part of the front of the chest; there was extended dulness on percussion in the cardiac region. Upon auscultation a loud double murmur was audible both at apex and base. A systolic murmur was heard in the carotids, the abdominal aorta, and in the brachial arteries. The pulsations of the carotids were conspicuous at a considerable distance from the patient.

This youth informed me that he was of temperate habits, had suffered several attacks of rheumatic fever, and had also been liable to *epistaxis* for several years. During the last six months he had been compelled to over-exert himself, and had suffered from shortness of breath.

The effects of the previous rheumatic endocarditis were here very conspicuous. It had caused serious structural changes in the aortic and mitral valves, so as to allow of regurgitation at each of those orifices, and hence had arisen also hypertrophy of the heart.

Under the combined influence of local depletion from the chest, of diuretics, and of rest, this lad got rid of the dropsical effusions in the course of a week. On the 30th May there was very little cough remaining; the pulse 72; the swelling of the legs had entirely disappeared; there had been a slight epistaxis during the preceding night; his appetite was returning: he was allowed some animal food; a tonic was administered, as well as occasional doses of a saline purgative. Upon this plan he continued improving during the ensuing three weeks, having had two or three slight returns of epistaxis.

On the 20th June he complained of giddiness; the pulse 80, fuller, but thrilling; the bowels open three times daily; there was no cough, nor swelling in any part, nor epistaxis. On the 24th June the nose bled to the amount of four ounces, with much relief to a "dizziness of his head."

On the 27th June he suffered from a prolonged attack of palpitation, which came on in the night, and was followed by troublesome headache in the morning. The impulse of the heart was increased, and the murmur at the apex harsher. He was purged freely, but on the following day he was seized with epistaxis, and lost upwards of a pint of blood. He continued in the hospital until the 29th July, having much improved in his general health. The cough had disappeared; there was no return of anasarca; the epistaxis recurred to a moderate amount about once in each week; the cardiac auscultation remained unaltered.

In the above-detailed case the bloody expectoration, the serous effusions in the limbs, and the recurring epistaxis, were all due to the serious cardiac lesions. At the time of his admission, the blood, regurgitating through the left cavities of the heart, had produced pulmonary congestion and hæmoptysis, as well as general venous congestion, followed by serous effusions. When the system was relieved of the effusions, and the heart had had an opportunity of recovering its power, the hypertrophied left ventricle soon induced congestion of the vessels of the head, giving rise to giddiness, dizziness, headaches, and these symptoms were relieved by returns of copious epistaxis. It was interesting to watch this succession and alternation of physiological phænomena.

In the foregoing case, as in the preceding, had the individual been twenty years older, he would in all probability have suffered from apoplexy with cerebral hæmorrhage, instead of being attacked with epistaxis.

Case IV.—In the summer of 1841 I was requested to visit Mrs. B——, æt. 70, residing in Cleveland Street, Fitzroy Square. I found her suffering from profuse epistaxis, which had caused much alarm. Upon examination of the heart, I discovered evident signs of hypertrophy and valvular disease in that organ. The epistaxis was controlled by local depletion, purgatives, and rest. About two years afterwards I was called upon to attend the same individual in an attack of apoplexy followed by hemiplegia, in which she rapidly sank.

Case V.—On the 2d February, 1846, I was requested by Mr. Gayleard, of Beaumont Street, to visit a patient with him.

A robust man, æt. 45, had for some months been suffering from severe pain in the forehead, giddiness, and pain in the chest. He had been bled from the arm a few months since for these complaints, and with some temporary relief. On the 23d of January, 1846, he had been attacked with pain in the abdomen, flatulence, and diarrhœa. These symptoms had been mitigated by appropriate remedies, and on January 30th he was seized with profuse epistaxis, which continued through two days, the hæmorrhage having been encouraged in the hope of relieving his headache. He passed a restless night on February 1st, with much starting in his sleep; and on the morning of February

2d he was seized with a convulsive fit, which ended in insensibility with stertorous breathing. His medical attendant found him in this state shortly after the fit, with the vessels of the face and scalp much congested. He immediately abstracted eighteen ounces of blood by venesection, applied cold to the head, elevated the upper parts of the body, and put mustard poultices to the legs. I visited this patient two hours afterwards. I found him still unconscious, but occasionally becoming sufficiently sensible to express a sense of pain produced by the mustard cataplasms. His face was pallid; the conjunctiva exsanguined; the pupils dilated; the iris immoveable; the skin cool; the pulse 80, and soft; respiration laborious, and occasionally stertorous; slight spasmodic jerks of the extremities occurred every now and then, but no paralysis could be discovered.

Upon auscultation, the impulse of the heart was found much increased, and accompanied with a harsh murmur, audible all over the cardiac region, but loudest at the base and in the aorta; but the restlessness and inconvenient posture of the patient precluded a careful examination with the stethoscope.

All further depletory treatment was desisted from, the position of the head was lowered, cold was applied to the forehead, and small doses of diffusible stimulants were prescribed.

In the course of the day two more convulsive fits occurred—one in my presence. The pupils were fixed; the breathing stertorous; the pulse almost imperceptible at the wrist, and the insensibility complete after the convulsion. Counter-irritation and other remedies were employed without benefit. The patient died in the course of the night, and his body was examined eighteen hours after death.

The face of the corpse was pallid, and its limbs rigid.

Head: There was serous effusion in the arachnoid, pia mater, and at the base of skull, to the amount of two or three ounces. The large veins on the surface of the brain rather full; the substance of the organ firm, not more vascular than normal; the ventricles contained about an ounce of serum; the plexus choroides pale; no extravasation of blood in any part of the brain. A stream of fluid blood ran from the projecting orifices of the internal carotid arteries into the base of the skull, when the head was dependent.

Chest: The right lung was healthy; universal firm adhesions of the left pleura. The pericardium contained about an ounce of serum; there was a circular patch of hard, rough lymph on the apex of the heart, where the free surfaces of the pericardium were adherent. The right chambers of the heart were natural; the left auricle large, its internal lining thickened and opaque; the edges of the mitral valve thickened, but not so as to prevent its closure of the orifice; the left ventricle nearly double its normal size, and its muscular walls one-third thicker than usual; the aortic valves efficient, but reticulated at their edges.

In the foregoing case there was a long continuance of symptoms referrible to the brain, but after death no disease could be detected in that organ; while the left ventricle of the heart was much hypertrophied. As the valvular disease of the heart discovered was inconsiderable, it is most probable that the adhesions of the pericardium at the apex of the heart had been the exciting cause of the hypertrophy. The pericarditis, which was probably coeval with the extensive pleurisy of the left side, had, no doubt, been of long standing. The firm condition of the organised adhesions in the pericardium warranted this conclusion. The hypertrophy of the left ventricle had gone on, by a well-known physiological law, gradually increasing to the amount described: ultimately the heart had become too powerful for a healthy condition of the cerebral circulation. Hence the vertigo, cephalæa, and at last the profuse epistaxis. The loss of blood by this hæmorrhage, and subsequently by the venesection performed at the time of the fit, had brought the system into a state of anæmia from which it was unable to rally. This case is strongly corroborative of the necessity of examining into the state of the heart in epistaxis when it occurs unexpectedly in adults.

It would be easy to cite other cases of a similar nature from the hospital case-books; but enough has been advanced to show the frequent relation subsisting between epistaxis and structural changes in the heart. Hence we learn, that if congestion of the vessels of the head be produced by an hypertrophied heart, that in one case it will be relieved by epistaxis, while in another it gives rise to the more serious accident of hæmorrhage within the cranium.

If the foregoing observations be correct, they impart an additional significance to the occurrence of epistaxis, which is often regarded as an isolated and unimportant symptom. This hæmorrhage may, I believe, often be considered as strictly pathognomic of an obstructed circulation through the heart, as hæmoptysis is symptomatic of tuberculated lungs, or intestinal hæmorrhage of an indurated liver.

There is another class of patients who suffer from a variety of cerebral symptoms, of which the most prominent is *headache*, and where the primary disease, or cause of those symptoms, is hypertrophy of the heart.

These persons generally have pallid faces, and peculiarly hard incompressible pulses; they are troubled with severe and obstinate headache, vertigo, some impediment in the speech, muscular tremors, or imperfect palsy. The histories of these patients almost invariably agree in one particular—that they have been addicted to spirit drinking; they are also liable to be attacked with profuse hæmorrhages, and ultimately become affected with general dropsy. My attention was first directed to these patients by Dr. Latham, and numerous instances have I since seen, and the more closely I have studied them the more frequently have I found such persons labouring under hypertrophy of the heart without evidence of great valvular obstruction, but perhaps combined with albuminous urine.

All who have paid attention to the peculiarities of the pulse in diseases of the heart, will agree in the correctness of the observation of M. Bouillaud, that in great hypertrophy of the heart there will be no correspondence between the violent impulse of that organ and the volume of the pulse. In truth, the smallness of the pulse strangely contrasts with the energy, the violence, and extent of impulse of an hypertrophied heart, especially if that be combined with serious disease of the mitral valve; but then, in hypertrophy without much valvular disease, the pulse is peculiarly hard and vibrating; in fact, just the sort of pulse I have alluded to as attendant on these obscure cerebral affections. I believe these cases are examples of another class of nervous affections depending upon confirmed cardiac disease; although it must be remembered that some part of the distress of the brain in these cases most probably arises from the deleterious influence of the vitiated blood upon the nervous substance.

No physician ever observed the general symptoms of diseases of the heart with greater accuracy than the celebrated Corvisart. It will therefore be interesting to advert to the results of his observation on the effects of diseases of the heart upon the functions of the brain.

In describing the general symptoms of hypertrophy and dilatation of the heart, he remarks, that in all stages of their progress the functions of the brain are disturbed. The patient suffers from frequent and obstinate pain in the head, from dazzling of sight, from numbness of different parts; he becomes gloomy, impatient, and irascible. As the disease advances, sensations approaching to syncope, or globus hystericus, are experienced. The sleep at nights is often broken by frightful dreams, which cause the patient to awake with starting; and during the day he becomes more capricious, impatient, and irritable. In the advanced stages of cardiac disease the functions of the brain are still more disturbed. The senses become dull; sometimes there is delirium at night; the patient suffers from an indescribable sense of muscular debility; a continual anxiety torments him, to such a degree that a furious despair makes him long for death, and even sometimes prompts him to seek it by his own hands.*

The picture is by no means overdrawn by Corvisart, and must be familiar to the physicians of public hospitals, where the most aggravated cases of cardiac disease are met with; and where such affections, with all the accompanying nervous depression, occur in individuals who have long pursued a course of intemperance, giving unbridled licence to their passions, and who have no principles to sustain them in the midst of their bodily sufferings.

But it is not only in hospitals that the symptoms described by Corvisart, mitigated probably in intensity, are presented to our notice. Middle-aged persons, of both sexes, in the upper ranks of society, apply occasionally for medical assistance, and who are suffering from uneasy sensations in the head, lowness of spirits, feelings of debility, occasional faintness, disposition to sigh, urgent desire for fresh air about them, irritability of temper, incapability of steady occupation, disturbed rest at nights. Such persons are often supposed to be dyspeptic, hysterical, nervous, or on the verge of insanity. Neither they themselves, nor their ordinary medical attendant, have suspected the existence of any disease of the heart. Auscultation in these cases has several times revealed to me the physical signs of valvular disease in the heart, or of serious changes in the aorta, and then, upon more close inquiry, other symptoms indicative of interruption to the course of the blood through the heart are confessed to.

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* Treatise on Diseases of the Heart, chap. iii. sect. 1.

The history of such individuals often informs us that they have suffered from rheumatic fever many years before, or they have had some previous severe inflammatory affection of the chest, most commonly pleurisy; or they remember, under the influence of mental excitement or bodily exertion, many years ago, having felt some peculiar sensation in the cardiac region, or that they suddenly fainted. The subsequent progress of such cases soon develops many more unequivocal symptoms of confirmed cardiac disease.

Dr. Clendinning, whose original researches into cardiac pathology I have already alluded to, states* that he has known many cases of inflammatory disease, and several of mania and delirium tremens, which, although of no extraordinary severity in themselves, proved fatal, notwithstanding all the usual remedial means; and such event was wholly owing, as Dr. Clendinning thought, to their complication with hypertrophy or other affections of the heart. These latter observations perfectly coincide with my own experience; and so assured do I feel as to the influence of diseases of the heart upon the functions of the brain, that I have little doubt but that if auscultation were generally employed among the insane patients in the large lunatic asylums, that numbers would be found suffering from cardiac lesions, which, by disturbing the cerebral circulation, tend to keep up the disordered functions of the brain.

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* Croonian Lectures, London Medical Gazette, vol. xxii. p. 725.

Many pathologists, of late years, have pointed out the double origin of disturbance to the functions of the brain and spinal cord, either *centric* or *ex-centric.* This principle is equally applicable to insanity as to other cerebral disorders. I believe it will be found that diseases of the heart play their part as an excentric cause of irritation, exciting or increasing disorders of the intellect to an extent which is not at present suspected.

In conclusion, I must express my conviction, that in obscure or intractable head affections, if practitioners would more generally take the precaution of scrutinizing the state of the heart by auscultation, with the same pains they bestow in ascertaining the characters of the radial pulse, they would often find an explanation of the peculiarity of that pulse in such cases; they would also discover a clue to the better understanding of the pathology, and the more successful treatment of this difficult class of diseases.

SECTION VII.

ON AFFECTIONS OF THE BRAIN AND SPINAL CORD DEPENDING ON ACUTE DISEASES OF THE HEART.

The influence of chronic structural changes in the heart, such as hypertrophy, dilatation, and valvular diseases, in disturbing the functions of the brain, has been already discussed in the preceding sections. My object, in the present section, is to direct attention more closely to a class of cases which are often misunderstood, where all the symptoms indicate a severe affection of the nervous centres, but which in reality depend on disturbance of the cerebral circulation, or on actual pain produced by acute disease in the heart and its membranes.

Different systematic writers on diseases of the heart have incidentally mentioned, that inflammatory affections of that organ are sometimes accompanied with such severe symptoms of nervous irritation, that the primary affection of the heart is either overlooked altogether, or is so masked by the nervous disorder that it is not detected until irreparable mischief is done to a vital organ. A few cases of this kind are to be found recorded in periodicals, and in the Transactions of different medical societies, during the past twenty years. But a connected view of these remarkable and fearful cases has not, as far as I know, been hitherto presented to the medical public. Without arrogating to myself any merit for originality in the view of them which I am about to offer, I think a synopsis of them will be a suitable illustration of the great pathological principle I have been upholding in the previous sections, viz. the influence of modifications of the circulation on the functions of the brain.

The earliest recorded case of this kind is that detailed by Mr. Stanley*. Dr. Abercrombie, in 1821, communicated a nearly similar case to the Medico-Chirurgical Society of Edinburgh, in a paper entitled, "Contributions to the Pathology of the Heart." It is singular that this valuable essay from so distinguished a physician should have escaped the notice of (I believe) all subsequent writers on diseases of the heart. Dr. Latham was the next in the order of precedence to call attention to this deceptive form of cardiac inflammation; and he informs us†, "that when he first related the particulars of his case to several medical friends, they looked incredulous, or rather contemptuous, of the man who would mistake an inflammation of the pericardium and heart for an inflammation of the brain." Nevertheless, I shall give a short account of many analogous cases, occurring in the practice of men of eminence both in Paris and in London. How many others have occurred in the practice of physicians who have been less candid in recording their mistakes, and how great a number must have happened in the practice of those who were unable, or who took no pains, to distinguish these deceptive cases, it is impossible to say. Andral[*] and Bouillaud[†] have recorded cases of this kind, as well as Dr. Copland[‡], Dr. Macleod[§], Dr. F. Hawkins[‖], and a few others in this country. But the most interesting and valuable information upon this subject has been given to the profession by Dr. Richard Bright, in his account of "Cases of Spasmodic Disease accompanying Affections of the Pericardium[¶]."

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* Transactions of the Medico-Chirurgical Society of London, vol. vii. 1817.

† Pathological Lectures on the Heart, London Medical Gazette, vol. iii.

Dr. Hope, in his elaborate Treatise on the Heart, remarks, that those cases of disease of that organ which simulate an affection of the brain are very rare. It is certainly remarkable that, with his unremitting attention to diseases of the heart, he never met with a single instance in his own experience. It has so happened that six such anomalous and deceptive cases have come under my observation; and hence I have reason to believe that they are of more frequent occurrence than is commonly supposed[**].

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[*] Clin. Med.

[†] Traité sur les Maladies du Cœur.

[‡] Dictionary of Medicine.

[§] On Rheumatism.

[‖] Gulstonian Lectures on Rheumatism.

[¶] Med. Chir. Trans. vol. xxii.

[**] I regret that, at the time these lectures were composed and delivered (Feb. 1843), I was unaware that four similar cases had been previously recorded by Dr. Watson: I had, indeed, perused the Lectures on Carditis and Pericarditis of that author, as reported in the London Medical Gazette (vol. xxix. p. 695), but they contain merely a general statement that patients labouring under rheumatic carditis frequently become maniacal, and are supposed to be labouring under inflammation of the brain or its membranes. I find, however, in the Lectures on the Practice of Physic subsequently published by Dr. Watson (2 vols. 8vo. 1843) that in Lecture LXI. on Carditis, he has incorporated the substance of an interesting Clinical lecture on these cases delivered by him at the Middlesex Hospital in 1835.

Authors on diseases of the brain and spinal cord have, indeed, pointed out the numerous extraneous sources of irritation capable of inducing symptoms of disordered functions of those nervous centres. Such symptoms have often been mistaken for the effects of morbid changes going forward in those centres; but, as far as I have been able to ascertain, these authors have scarcely ever alluded to acute diseases of the heart as the sources of irritation to the nervous centres.

In Dr. M. Hall's recent volume "On Diseases of the Nervous System," he devotes a chapter to the consideration of those affections which he terms of "remote origin." The effects on the nervous system from intestinal inflammation, from loss of blood, chlorosis, gout, shock, and affections of the kidney, are there carefully pointed out; but he only incidentally alludes to those remarkable disorders of the nervous centres excited by active inflammation of the heart and pericardium.

Having given this concise summary of the scattered information we possess on this interesting point in the history of diseases of the heart, I shall now direct attention to a series of cases of inflammation of the tissues of that organ, where the disease was altogether mistaken for affections of the brain and spinal cord, or, where the prominent symptoms were referable to those nervous centres. I shall show that there is scarcely an affection of the cerebro-spinal system which may not be simulated by inflammatory diseases of the heart and its membranes.

I shall begin with citing (1) some cases which were marked with all the usual symptoms of inflammation of the brain and its membranes; (2) cases simulating mania and dementia; (3) cases characterised by apoplectic and epileptic symptoms; (4) cases with well-marked symptoms of tetanus and trismus, and, (5) others, still more numerous, accompanied by symptoms of aggravated chorea and hysteria.

In adapting these various cases to the object I have in view, I have necessarily been obliged to curtail the histories of some of them as they stand in the original authors.

CASE I.—*Active Articular Rheumatism, complicated with Carditis and Pericarditis, presenting the ordinary symptoms of an Inflammatory Affection of the Brain.*

In April, 1816, one of the boys at Christ's Hospital was attacked with febrile symptoms, and pain in one thigh and knee. The pain in the limb quickly subsided, when he became restless, sleepless, and delirious. When asked if he suffered pain, he pointed to his forehead. On the third day of his illness he had a kind of convulsive fit, which soon went off. He passed another restless night with delirium, and gradually sank into fatal coma on the fourth day, never having complained of any pain in the chest throughout his illness.

It having been considered, from the general character of the symptoms, that there was inflammation going forward in the brain, all the remedies were directed to that organ; and upon examination of the body the head was first inspected. But after an attentive examination of the brain nothing further could be remarked than that the vessels were generally turgid; not more so, however, than is frequently seen when death has taken place under circumstances that led to no suspicion of affection of the brain. Upon opening the pericardium, it was found to contain between four or five ounces of turbid serous fluid, with flakes of coagulable lymph floating in it. The entire free surface of the pericardium, both of the loose and reflected portions, was covered with a thin layer of lymph, exhibiting a reticulated appearance. Upon cutting through the parietes of the heart, the muscular fibres presented an exceedingly dark colour. The fibres were also very soft, and loose in their texture, easily separable, and with facility compressed between the fingers. Upon looking closely to the cut surfaces, numerous small collections of dark-coloured pus were visible among the muscular fibres.

The internal lining, valves, and every other part of the organ, exhibited nothing worthy of remark, except a state of general turgescence of the capillary vessels, and that all the cavities of the heart were loaded with coagulated blood.

Upon this interesting case Mr. Stanley makes the following remarks*. "We here have presented to our consideration an instance of inflammation attacking the heart, so violent as to pass immediately into suppuration, and at the same time so destructive as to prove fatal in four days from its commencement; and yet of the symptoms which arose, there was not one which appeared directly referable to the affected organ; on the contrary, from their general tendency, the attention was diverted from the central organ of the circulation, the actual seat of disease, to the centre of the nervous system, where there existed no organic derangement.

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* Transactions of Medico-Chirurgical Society, vol. vii.

The following case, which occurred under my own observation, presents many points of resemblance to that which has just been detailed.

Case II.—*Active Pericarditis and Carditis (Rheumatic?) accompanied with Delirium and other symptoms of Nervous Irritation.*

On January 19th, 1843, S. H., æt. 13, a shop-boy, of delicate constitution, was admitted into St. Bartholomew's Hospital, under my care. He complained of severe pain in the right iliac fossa, groin, and thigh. There was some redness, swelling, and hardness of these parts; there was also some pain in the right upper arm, without swelling or redness. His countenance was expressive of much suffering, and he moaned frequently; the eyes were suffused, and the nostrils dilated; the external jugular veins turgid and throbbing; the respirations 48; the pulse 136, sharp, but compressible; the skin of the body warm, the feet cold; the tongue dry, with a red streak down its centre; the bowels open. He made *no complaint of pain about the chest*, but a short systolic murmur was audible at the base of the heart.

He informed me that, five days previous to his admission, he had been seized with shivering, loss of appetite, and vomiting; and that two days afterwards the pain came in the groin and other parts.

He was ordered—

Hirudines viii. regioni iliacæ dextræ. Cataplasma postea.
Sumat. Hyd. Chlor. gr. j.; eum Antim. Pot. Tart. gr. $\frac{1}{8}$ 6tis horis.

Jan. 20th—He had passed a restless night, with much delirium; his manner is excited, and he cries out with pain in the groin and thigh. The other symptoms unaltered. He makes no complaint of pain about the chest, but a soft systolic murmur is audible at the base of the heart. The same remedies to be repeated.

He was delirious and restless through the next night; his countenance became exceedingly anxious; he moaned continually, and was incoherent; he complained less of the former pains, but upon proceeding to examine the chest, he referred his pain to the præcordium; percussion here aggravated his pain, and elicited extensive dulness; a harsh friction sound was audible all over the cardiac region; the pulse 144, weaker; the respirations 72, laborious; the skin hot and dry, with erythema papulatum over the trunk and limbs. He was cupped from the cardiac region, frequent doses of calomel and opium, with mercurial inunction, were ordered, and in the evening a blister was applied to the chest. These remedies afforded no relief, and he expired the following morning, having been delirious and moaning to the time of his death.

Upon examination of the body, the whole surface of the pericardium was found covered with a network of recent lymph; there was about an ounce and a half of turbid serum in its sac. Upon the anterior surface of the left ventricle of the heart there was a white spot, about a quarter of an inch in diameter. Upon cutting through this it appeared to be formed by concrete pus; the muscular tissue around was congested and soft; the muscular substance of other parts of the heart was paler than natural; the endocardium and valves were perfectly healthy. Both lungs were greatly congested, dark, and studded with masses of pulmonary apoplexy. The iliac vessels and other parts of the abdomen natural. The head was not examined.

CASE III.—*Idiopathic Pericarditis giving rise to Chorea, and symptoms of an Inflammatory Affection of the Brain.*

A young lady, æt. 16, came under Dr. Abercrombie's care on the 8th of January, 1812, complaining of acute pain at the pit of the stomach, with very short breathing: pulse generally 130, extreme restlessness, almost no sleep, with a good deal of delirium. In the third week, after antiphlogistic treatment, the pain abated, and she could take a full breath. Afterwards she fell into a state resembling chorea, with convulsive agitations of the limbs, constant motion of the head, wild rolling of the eyes, and delirium, which soon increased to such a degree that for several days she was with difficulty kept in bed. She no longer complained of pain; the breathing was natural; the pulse 120, and small. After this she gradually recovered her usual health, but on the 20th of April, upon exposure to cold and fatigue, she was seized as before, but the pain was more towards the left side. It was accompanied with dyspnœa, anxiety, and restlessness. She died on April 26th, with increased dyspnœa, great anxiety, vomiting, and rapid sinking of the vital powers.

Upon dissection, a thick layer of soft coagulable lymph was found interposed between the surfaces of the pericardium, which were adherent throughout. There was a deposition of the same kind upon the exterior of the pericardium, in some places nearly half an inch in thickness. The surface of the heart was dark-coloured, and very vascular. The lungs were in some places indurated. The other viscera were healthy.

After detailing six other cases of pericarditis terminating fatally in the acute stage, Dr. Abercrombie observes*, "a remarkable circumstance in the history of this dangerous affection is, that it may be going on rapidly, yet insidiously, while our attention is occupied by symptoms which have no relation to it."

Cases IV. and V.—*Pericarditis, without any signs of Rheumatism, giving rise to Symptoms of Inflammation of the Brain.*

Dr. Latham has recorded† the case of a young woman, which is strongly impressed upon my recollection, who was admitted into St. Bartholomew's Hospital in 1828, and in whom all the symptoms led to the belief that the brain was inflamed. The whole force of the treatment was therefore directed to that organ. The woman died; and upon dissection, the brain and its coverings were found in a perfectly healthy and natural state, and the pericardium, towards which there was no symptom during life to induce the slightest suspicion of disease, exhibited unequivocal marks of acute inflammation.

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* Contributions to the Pathology of the Heart. Transactions of the Medico-Chirurgical Society of Edinburgh, vol. i. 1821.

† Medical Gazette, vol. iii.

Case V.—Another woman, æt. 40, was admitted, in 1839, into St. Bartholomew's Hospital, suffering under slight delirium, fever, and other symptoms of an inflammatory affection of the brain. She was treated for this supposed affection of the brain, and did not present a single symptom referable to the heart. She sank in about four days after admission. No disease was found in the brain or its membranes: the free surfaces of the pericardium were coated with thick honeycomb lymph, which had evidently been effused within a few days previous to her death.

There appears to be one peculiarity common to three out of the five cases I have just recited, which was, that, throughout their progress, there was no symptom present which directed attention to the organ affected. In the case recorded by Dr. Abercrombie, the patient had, it is true, complained of pain in the epigastrium, and of dyspnœa, before the accession of the symptoms of affection of the brain and spinal cord; and these symptoms caused his treatment to be addressed near to the organ affected. Nevertheless, this case, as well as the other four, proved fatal.

CASE VI.—*Rheumatic Pericarditis, attended with Chorea and Symptoms of Inflammation of the Brain and Spinal Cord.*

In April 1836, Dr. Richard Bright was summoned to attend a young man, æt. 17, who, twelve days previously, had been attacked with rheumatism. On the sixth day of the disease spasmodic symptoms appeared; and at the time of Dr. Bright's visit he was labouring under symptoms of severe chorea, the spasms being more violent than almost ever seen in that disorder. Although no particular symptom pointed out disease of the heart, still it was rather suspected. In a few days the spasms assumed the character of the most violent convulsions; his speech became indistinct, there was difficulty in opening the mouth, and the mind began to wander. The delirium gradually increased until it was absolutely necessary to put him under personal restraint. He died at the end of three weeks. In this case lymph was found effused in abundance on the interior of the pericardium, and, to a slight extent, on the exterior of that membrane. The valves of the left side of the heart were fringed with vegetations. The brain was perfectly healthy*.

CASES VII. AND VIII.—*Rheumatic Pericarditis detected during life, accompanied with Symptoms of Inflammation of the Brain, and terminating in Recovery.*

Dr. Macleod† has recorded two cases of rheumatic pericarditis in which symptoms of inflammation of the brain supervened, and which were both successfully treated. The first, a young woman, æt. 27, was admitted, in the third week of rheumatic fever, into St. George's Hospital. On the following day some incoherence was remarked, and the physical signs of pericarditis detected. On the third day constant delirium supervened, with restlessness and jactitation, so that it was necessary to put on a strait-waistcoat. At the expiration of a week the delirium began to subside; and, on examination of the heart, the friction-sound had disappeared, but the sounds and impulse of the heart were feeble, distant, and intermittent. She gradually improved during the ensuing ten days, when she was twice affected with a convulsive fit of an epileptic character. From this time she progressively improved.

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* Medico-Chirurgical Transactions, vol. xxii.

† On Rheumatism, &c.

The treatment of this successful case consisted of bleeding, once generally, and once locally, calomel and opium, with purgatives, and blisters to the chest.

The second case, related by Dr. Macleod, occurred in a man of intemperate habits, æt. 39, who was admitted, Sept. 1837, into St. George's Hospital, labouring under acute rheumatism of three weeks' duration. He was bled, purged, and took calomel and opium. On the fourth day after his admission, he was observed to be incoherent, with much wildness of expression. His mouth was already affected by mercury, and he was therefore ordered a grain of opium every six hours. On the following day the delirium had increased, so that at times he was unmanageable, and he had a fit.

The physical signs of pericarditis were now detected. During the five following days the same symptoms persisted, and were treated with repeated doses of the acetate of morphia. From this period the delirium declined, and the friction-sound disappeared. He gradually recovered; and after a time the sounds of the heart became natural.

I think we can hardly attribute the success which attended the treatment of these two last-mentioned cases, as compared with the want of success in the five preceding instances, to any other circumstance than the early detection of pericarditis by its physical signs. In these two encouraging cases there does not appear to have been any symptom referable to the heart prior to the occurrence of the delirium, and the physical signs of pericarditis were not detected until after the supervention of the peculiar cerebral symptoms.

In the two following cases of rheumatic pericarditis we shall remark a still further, more serious, and permanent injury done to the brain. In both, indeed, life was preserved; the one, however, terminating in dementia, the second in insanity.

CASES IX. and X.—*Rheumatic Pericarditis, accompanied with Chorea, ending in Dementia in one case, and in Insanity in the other.*

A housemaid, æt. 24, was admitted into St. Bartholomew's Hospital, Aug. 23, 1838, under the care of my colleague, Dr. F. Farre. She was suffering from rheumatism, affecting almost every joint of the body, and causing the most acute suffering, together with much fever. On the following day the respiration was observed to be hurried, and accompanied with pain about the præcordia. Auscultation at this time discovered no unnatural sound about the heart. She was bled from the arm; cupping-glasses were applied beneath the scapulæ; calomel and antimony administered internally, and then colchicum. At the expiration of a week her pains still continued, and as the colchicum had disturbed the stomach and bowels, it was determined to treat the case with opiates. During the ensuing week her pains declined, not uniformly, but rather remitting; her nights, however, were sleepless. On the 8th of September, I was requested to see her. I found her sitting up in bed, moaning and wringing her hands, with a vacant expression of countenance. She did not appear conscious of what was passing around her, or scarcely so; she did not answer questions, or only in monosyllables, and when much urged; she occasionally put her hand to her head, when questioned about pain there. During the previous night she had been wakeful, delirious, and constantly getting out of bed. I immediately suspected the nature of the case, and, by a careful auscultation, was able to detect a to-and-fro friction-sound over the whole præcordial region. She was again depleted twice locally, calomel and opium were administered freely, mercurial inunction commenced, and a blister applied over the cardiac region. In spite of these remedies, the delirium continued during the ensuing week, the rubbing sound still being audible; she became purged and exhausted with the mercury, without affection of the gums. Milder mercurials, with opiates, leeches, and a blister to the chest, were now employed, and she was removed to a separate ward on account of her delirium disturbing the other patients. Her condition remained, however, nearly the same, being delirious throughout the month of October. In the beginning of November she became more tranquil, and even took some part in the nurse's duties in the ward. She never spoke, unless to answer questions, and then very briefly. She was discharged on November 19th, nearly in this condition, having had no return of rheumatism, nor at this time could any unnatural sound of the heart be heard.

On Oct. 25, 1838, a girl, æt. 16, was admitted into the same ward, suffering under rheumatism, which was not very severe. On November 2d she appeared very restless, and kept constantly moving about her arms, but not in that jerking manner commonly observed in chorea; her manner, too, appeared strange, and when addressed she did not answer the questions which were put to her, but spoke of something else, and then after some hesitation. The movements of the arms and legs became, in a day or two, more violent; she was continually delirious, and it was necessary to employ personal restraint. Her rheumatism disappeared, and I was informed, for I did not see her until a later period, that there was no unnatural sound of the heart.

She continued in this state until November 8th, when the chorea gradually subsided, but the strangeness of manner remained up to the time of her discharge, December 3d, 1838. She, however, answered questions more readily, but was harassed by delusions, insisting that she was in Newgate, whither she had been sent for her wickedness.

It was remarkable that this and the former patient, although they never spoke to each other, were always to be found together, in whatever part of the ward they might happen to be, where they sat and looked at each other, regardless of anything else.

Although the physical signs of pericarditis, or endocarditis, were not detected in the last described case, I think that when its history is compared with other similar affections of the nervous system, coming on in the course of rheumatism, there can be little doubt as to the existence of an insidious cardiac inflammation in this patient also.

CASE XI.—*Rheumatic Endocarditis, complicated with Symptoms of partial Insanity.—Recovery.*

L. B——, æt. 18, a healthy-looking girl, was admitted into St. Bartholomew's Hospital, under my care, on Jan. 2d, 1845, complaining of painful swellings of several large joints, of want of sleep, and of loss of appetite; the pulse 78, full; the skin warm. The pains had commenced three weeks previous to her admission, after exposure to cold and wet; she had been under medical treatment, without relief to her complaint. On the day after her admission, a harsh systolic murmur was detected both at the apex and base of the heart. The respiratory sounds were healthy. She was ordered—

Hydrarg. Chlor. gr. iij. cum Pulv. Ipecac. Comp. gr. v. omni nocte sumenda.
℞—Tinct. Colch. ♏x. c. Potassæ Bicarb. gr. x. ex Aquæ Pimentæ ℥iss. ter die.
Emplast. Cantharidis sterno.
Haust. Sennæ Comp. p. r. n.

No material change in her symptoms took place during the ensuing week; her pains still continued to disturb her rest; the pulse fell to 56, and was thrilling. The calomel was henceforth discontinued.

Sumat Pulv. Ipecac. Comp. gr. x. omni nocte.
Haust. Tinct. Colchici ter die.

At the expiration of another week her pains had gradually subsided; she slept well; the pulse 60, full but soft. All medicines were omitted.

On Jan. 16th, she was reported to have slept very little during the preceding night, but had been sitting up in bed, calling out to the nurse, and declaring that she had vermin crawling over her. At the time of the visit she was dejected, and would hardly answer any questions: her expression was languid and heavy; skin warm; tongue moist; pulse 60, full, soft, and rather thrilling; a faint systolic murmur was still audible at the base of the heart.

℞—Sp. Ammoniæ Comp. ʒss. ex Mist. Camph. ℥iss ter die sumend.
Oj. of beef-tea daily.

She continued in the same languid state, with low spirits, and various strange fancies, unwilling to take her food, or to answer questions, up to the 21st. She then complained of some pain and fulness over the forehead and eyes; the pulse 72, rather fuller, but soft and thrilling.

R—Quinæ Disulph. gr. ij. cum Acidi Sulph. dilut. ♏v. ex Aquæ Menth. Vir. ter die.
Port wine ℥iv. daily. Beef-tea.

From this date to the 26th February there was a very slow amendment.; her aspect and manner had now become more natural, although she was very taciturn; she took food more readily, and expressed a wish to return home. Upon the most careful auscultation no murmur could be detected in the cardiac region. She was discharged from the hospital on March 5th, completely convalescent.

The three last described cases have many points of resemblance, and each shows how completely the mental faculties may be disturbed, in consequence of irritation of the brain induced by acute cardiac inflammations*.

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* Whilst these sheets are passing through the press, another case of mental imbecility occurring in the course of rheumatic fever and endocarditis, has been under my observation.

F. C——, æt. 17. was admitted, under my care, into St. Bartholomew's Hospital, having been suffering, during the past six weeks, from a second attack of rheumatic fever. About twelve days before his admission, he was observed to be absent in manner, taciturn, and unwilling to answer questions; he also had twice awoke in the night, frightened, and raised a false alarm of fire. His countenance was pallid and vacant; he took no notice of surrounding objects; he made no complaint, but when interrogated, answered slowly, in monosyllables, to simple questions. He was much emaciated; pulse 100, and feeble; there was a harsh systolic murmur audible all over the region of the left ventricle.

In the course of a few days, purpurous spots were observed on the legs, and the knee-joints were again swollen. During the ensuing two months, he remained, with slight variations, in a state of great exhaustion of body and imbecility of mind. At the expiration of that time, an abscess formed in the right buttock, which was followed by extensive sloughing of the integuments of the back and

CASE XII.—*Pericarditis, attended with Symptoms of Apoplexy and General Paralysis.*

M. Rostan* relates the case of a woman who was admitted under his care, suffering from general uneasiness. On the second day she was suddenly seized with a complete loss of consciousness; her eyes were fixed; the eyelids open; the cheeks flushed; the pulse at the wrist, and impulse of the heart, scarcely perceptible; the limbs motionless, except when pinched. She remained in this state four days, and died.

The pericardium was found covered with false membranes, and bloody serum effused into its sac. There was no appreciable lesion in the other organs.

CASE XIII.—*Apoplexy occurring in the course of undetected Pericarditis, not Rheumatic.*

A young man, æt. 21, was admitted (March 1834) under the care of M. Bouillaud, labouring under general dropsy. Twelve days after his admission he was attacked with sudden loss of consciousness; his eyeballs were turned upwards; his breathing became

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hip. He then sank (April 1846), without any material improvement in the state of the mind, the cardiac murmur having persisted throughout.

The most careful examination of the encephalon after death detected no appreciable change which could account for the cerebral symptoms. The pericardium was healthy, and contained about two ounces of clear yellow serum; the heart was of normal proportions; the edges of the mitral and aortic valves were studded with numerous firm granules or beads of lymph. There were other morbid appearances in connexion with the abscess of the right buttock, but which had no reference to the original disease. The cerebral symptoms here were, no doubt, partly dependent upon the exhaustion of the system consequent upon protracted rheumatic fever.

* Recherches sur Ramollissement du Cerveau.

stertorous; his lips covered with frothy saliva; his limbs, instead of being thrown about in convulsive movements, were completely paralysed. On the following day he had two or three similar apoplectic seizures, which, however, did not last many minutes. He was also observed to be occasionally slightly delirious. On the fifth day after the appearance of these cerebral symptoms, the tumultuous action of the heart induced M. Bouillaud to examine the condition of that organ more carefully than he had previously done, when he distinctly ascertained the presence of the physical signs of pericarditis. On the following day the patient died.

Dissection discovered abundant effusion of lymph into the pericardium, with signs of endocarditis in the left ventricle, also recent adhesions, with some serous effusion into the right pleura, with extensive consolidation and softening of the right lung. The brain presented no morbid appearances. M. Bouillaud remarks* on this case, that without the assistance of auscultation and percussion it would have been impossible to have detected the pericarditis in this man. He never complained of pain in the region of the heart, and there was no suspicion of rheumatic inflammation in any part of the body. M. Bouillaud flattered himself that this pericarditis had come on in the night previous to his detecting its presence, and that it had been brought on by exposure to cold, when the man, in a state of delirium, went to the water-closet. It appears much more probable that the pericardial as well as the pneumonic inflammation had already made considerable progress at the time of the first apoplectic seizure.

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* Traité des Maladies du Cœur, tom. i. p. 319.

Case XIV.—*Undetected Pericarditis, accompanied with Symptoms of Inflammation of the Spinal Cord.*

Andral details* the following case of acute pericarditis terminating fatally, where the symptoms were those of inflammation of the spinal cord, delirium and tetanic spasm being especially prominent.

A woman, æt. 26, who had recently miscarried, was brought into La Charité Hospital with so much delirium, that no account of of her complaint could be obtained from herself. Her delirium was characterised by a remarkably obstinate taciturnity; her lips were observed to be drawn apart by convulsive twitches. On the following day her head was frequently drawn backwards, and her body thrown up in jerks. She appeared to understand questions, and answered, but was incoherent. On the fourth day after her admission the delirium disappeared. The muscles of the face were constantly convulsed, and her upper limbs every now and then became as rigid as in cases of tetanus. On the fifth day the delirium returned; her limbs were palsied; she fell into a state of coma, and died that evening. The only remedy employed was depletion by leeches from the back of the head.

On inspection of the body, the membranes and substance of the brain and spinal cord were found without the slightest morbid change; the surfaces of the pericardium were covered with soft lymph, and several ounces of turbid serum were contained in the sac. There was no disease of any other organ.

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* Clin. Med. t. i. p. 34.

M. Andral, in recording this curious case, recommends it to the serious attention of his readers. It appears to him to show, that in consequence of the idiosyncrasies of individuals, the lesion of any important organ may produce, sympathetically, the most varied nervous symptoms, such as are usually the consequence of disease in the nervous centres themselves. Although M. Andral describes delirium as one of the symptoms present in the foregoing case, yet there is no evidence of delirium in the report, beyond the obstinate taciturnity, which may have arisen from the inability to command the organs of articulation. This symptom, unwillingness, or inability to speak, is often very remarkable in some of these cases.

Case XV.—*Tetanus, in its most aggravated form, occurring in a case of undetected Rheumatic Pericarditis, which was treated as Inflammation of the Spinal Cord*[*].

A robust lad, æt 16, was admitted under the care of M. Bouillaud, in March 1834. A fortnight previous to his admission, he had had swelling of his hands and arms, which prevented him from working. Shortly afterwards he was seized with convulsive contractions of his fingers, which were regarded and treated as epileptic.

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[*] Bouillaud, op. cit. tom. i. p. 333.

At the time of his admission his eyes were fixed and haggard, and the pupils dilated. He had the aspect of a man who apprehended some great danger; his intellect was clear; but he replied to questions with a trembling voice, his articulation being interrupted by cries and sobs, called forth by severe cramps in his limbs, and a feeling of suffocation. The fingers, hands, fore-arms, toes, and feet, were violently contracted. The muscles of the lower jaw, of the abdomen and limbs, were as hard as stone during the spasms. The mouth was opened with difficulty. The whole body, but particularly the face and chest, streamed with perspiration, which became more abundant with the return of the cramps.

During the four succeeding days he suffered from repeated attacks of spasmodic contractions of the limbs, with more urgent symptoms of trismus. Any attempt to swallow aggravated his sufferings. During the continuance of these symptoms of tetanus the circulation was frequent, the skin hot or perspiring, the bowels constipated, and some dysuria was present. The disease was regarded as inflammation of the spinal cord, and treated by venesection, and repeated local abstractions of blood along the spine. Opium was administered internally, and a warm bath every day.

The patient died on the tenth day after the first appearance of the spasms in the fingers.

Dissection detected a general increased vascularity of the pericardium, with two ounces of pure creamy greenish pus in that serous sac, and old adhesions in either pleura. The brain and spinal cord, with their membranes, were generally congested. The spinal cord was rather firm, except at the superior enlargement of the cord, where there was a circumscribed spot of softening.

In this case pericarditis was never suspected, and its physical signs were not sought after. They probably would have been more obscure than usual, on account of the absence of fibrinous exudations, and the small quantity of purulent effusion into the pericardium. It is also worthy of remark, that although this case was treated by M. Bouillaud with active depletion, and by large doses of opium, nevertheless there was no alleviation of the symptoms.

Case XVI.—*Undetected Idiopathic Pericarditis, attended with Symptoms of Inflammation of the Spinal Cord.*

Dr. Macintosh* describes the case of a middle-aged man, who suffered from asthma, sleepless nights, cough, and expectoration, and, at the same time, from spasmodic contractions of the muscles of the extremities. On examining the chest he was found to have an extraordinary curvature of the spine, and to be chicken-breasted. He was unable to inflate the lungs completely. The action of the heart was tumultuous and irregular, occasionally intermitting. On the two succeeding days he appeared to improve under the treatment adopted, the case being regarded as one of chronic disease of the lungs, with enlargement of the heart. On the third day the oppression about the chest increased; but the chief suffering arose from cramps in his extremities, and an occasional spasmodic rigidity of the whole body, which was sometimes bent backwards, and supported by the occiput and heels, in complete opisthotonos. He died suddenly in the course of the following night, the spasms having been so severe that he could hardly be kept in his bed.

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* Practice of Physic, vol ii. 4th edition.

On dissection, the brain was found quite healthy. No trace of disease was found in the spinal cord, except one old adhesion of the membranes, and some ossific scales on the surface of the arachnoid. The pericardium was large, and contained a considerable quantity of turbid serum, with a deposition of lymph, adhering in several places to the surface of the heart. The heart itself was large; the valves were sound.

The cases of tetanus coming on in the course of pericarditis, which I have now related, should not remain mere pathological curiosities; they should suggest some useful practical rules in the treatment of that terrible nervous affection.

The pathology of tetanus is confessedly obscure: numerous cases of that disease have terminated fatally in the hands of the most able practitioners, when no morbid appearances could be found in the spinal cord and membranes. We are obliged to confess our ignorance of the nature of the morbid action in such cases, and affirm that the spinal cord has suffered from irritation.

Dr. Marshall Hall has applied certain generic terms to nervous affections, according as the source of irritation is situated in the brain and spinal cord, or elsewhere. When the source of irritation is within the nervous centres, he calls the affection *centric;* and when it is situated elsewhere, *eccentric.* The cases I have cited upon the present occasion are examples of eccentric tetanus, the source of irritation being in the nerves of the heart and diaphragm. Considering how obscure is the pathology, and how difficult the treatment of tetanus, it behoves every one henceforth, in cases of trismus and tetanus, which are not traumatic in their origin, to scrutinize the sounds and action of the heart by auscultation, and to seek for the signs of pericarditis. It is a melancholy reflection, but, I fear, a just one, that numbers have perished from these supposed diseases of the spinal cord, when, in truth, the morbid action has been in the heart, although that has not been detected.

The connection of chorea with inflammation of the pericardium has already been partially illustrated in the narratives I have just detailed (Cases II. V. and VIII.) I feel disposed to add but few observations on this part of the subject. It is, however, very fully discussed by Dr. R. Bright, in his "Essay on Spasmodic Diseases accompanying Affections of the Pericardium*." No less than five cases of this complication are there recorded by that physician, and he makes the following remarks on their pathology :—"The instances of the combination and alternation of rheumatism and chorea are very numerous; and though I doubt not, in some cases, (as supposed by Dr. Copland and others), the coverings of the cerebro-spinal mass may be and are implicated, yet I believe that the much more frequent cause of chorea, in conjunction with rheumatism, is the inflammation of the pericardium. The irritation probably is communicated thence to the spine; just as the irritation of other parts, as of the bowels, the gums, or the uterus, is communicated, and produces the same diseases."

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* Medico-Chirurgical Transactions, vol. xxii.

From this collection of cases, which I have analysed and detailed in the present section, we learn that all those groups of symptoms which indicate the most formidable diseases of the brain and spinal cord may arise from the irritation of the nerves of the heart, without any structural change in the nervous centres themselves.

It would thus appear, to employ the words of Andral, "qu'en raison des susceptibilités individuelles, il n'est point d'organe dont la lesion ne puisse déterminer les symptômes nerveux les plus variés, de manière à produire sympathiquement les différens états morbides dont on place le siege dans les centres nerveux et leurs dépendances*."

I will now venture to offer some remarks on the pathology of these cases, as a distinct class of nervous affections.

It has been supposed by some pathologists that these cases are only met with in connection with rheumatism, and particularly where pericarditis is engrafted on rheumatism of the joints; but of the sixteen cases I have narrated no rheumatic affection could be discovered in seven of them*. In two or three the pericarditis might be regarded as idiopathic; in the others it came on in the course of chronic diseases of various kinds.

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* Clin. Méd. t. i. p. 36.

Some writers affirm, that when peculiar nervous symptoms do appear in the course of rheumatism or pericarditis, that such nervous symptoms arise from a metastasis of the morbid action to the membranes of the brain and spinal cord. Without denying the occasional occurrence of such a phenomenon, I can only state, that in not one of the eleven fatal cases I have enumerated could a trace of disease be discovered in the brain or its membranes. In only two of the eleven did the spinal cord and its membranes present anything remarkable†. In the case of tetanus cited from the work of M. Bouillaud, the cord and its membranes were vascular, and there was also one small point in the cord softened. In the case of tetanus quoted from Dr. Macintosh, an old adhesion was discovered in the membranes of the cord, and some small ossific scales on the spinal arachnoid.

I have already alluded to the opinions of Dr. Bright on the pathology of some of these spasmodic affections, and the mode in which he supposes the nervous centres to become affected. I fully coincide with the general principle of his explanation. This able physician reports, that in the cases examined by him, the inflammation was not confined to the interior of the pericardium, but existed also on that part of the external surface of the pericardium, as well as pleura, where the phrenic nerve, in its course or distribution, is to be found. He therefore suggests the explanation, "that the phrenic nerve is the more immediate means of communicating the irritation to the spinal cord."

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* Cases III., IV., V., XII., XIII., XIV., XVI.

† In four fatal cases of rheumatic pericarditis, or endocarditis, accompanied with symptoms of cerebral irritation, which are recorded by Dr. Watson (op. cit. vol. ii. p. 280), there were no traces of inflammation of the brain, beyond an accumulation of serum beneath the investing membranes; "no redness, nor pus, nor lymph; none of the unequivocal products of inflammation" existed there.

In the case I have cited from Dr. Abercrombie's Essay, there was found, not only a large quantity of lymph within the pericardium, but also a layer of lymph, half an inch in thickness, on the exterior of the pericardium. This additional fact gives support to the explanation offered by Dr. Bright; which also derives further confirmation from some observations of M. Bouillaud on these remarkable cases.

M. Bouillaud, in reviewing the general symptoms of pericarditis, adverts to the extraordinary disturbance of the nervous system in some cases of this disease, and proceeds to analyse the peculiarities which have distinguished them. He finds that such nervous symptoms have occurred when pericarditis has been complicated with pleurisy, and especially with extensive diaphragmatic pleurisy. This opinion he supports by reference to some of his own cases, as well as to one recorded by Corvisart, where the patient, during life, was attacked with spasms of the muscles of the face, and delirium. After death, besides the pericarditis, there was discovered extensive inflammation of the pleura covering the diaphragm. The celebrated republican, Mirabeau, also died of severe pericarditis, complicated with pleurisy. The progress of his complaint was accompanied with the most distressing nervous symptoms, which caused him frequently to appeal to his philosophic friend and physician (Cabanis) to put an end to his agony by large doses of opium.

The explanation of M. Bouillaud of the pathology of these cases of pericarditis, with aggravated symptoms of nervous excitement, very closely coincides with that given by Dr. Bright. But the details of both fatal and favourable cases of pericarditis complicated with pleurisy, recorded in the work of M. Bouillaud, show that such cases are not necessarily attended with nervous excitement. I have known several instances of rheumatic pericarditis, complicated with pleurisy, where no peculiar nervous symptoms were present; on the other hand, I have seen a few cases of pericarditis where no pleurisy existed, and which were characterised by these strange nervous phenomena.

On this part of the pathology of the heart, Dr. Hope made the following remarks :—"The sardonic expression, and peculiar contortion of the features, attending the worst cases of pericarditis, are occasioned by the sympathy subsisting between the respiratory nerves of the face, and those of the heart. An impression is conveyed to the spinal cord through the pneumogastric nerves, and reflected to the face through the portio dura."

It would, therefore, from a more extended review of these cases, seem probable, that, although the spinal irritation may in some cases be excited through the phrenic nerves, the same amount and kind of irritation may be equally conveyed through the pneumogastric nerves.

Dr. Watson* has offered a different explanation of the pathology of these ambiguous cases, and which is strictly in accordance with the doctrines I have been attempting to establish throughout the foregoing sections. He is of opinion, that the disorder of the sensorial functions is not attributable to any inflammation in the brain, but is probably dependent upon disturbance of the cerebral circulation, occasioned by the embarrassment to the heart's action during the progress of acute inflammation of its tissues. This explanation I should deem correct, in those cases which have been characterised by stupor, apoplexy, and disturbance of the intellect; but in the other class of cases, which have been distinguished by spasmodic affections, it appears to me that our present knowledge of the functions of the nervous centres favours the explanation offered by Dr. R. Bright.

In collecting and collating the foregoing examples of endocarditis and pericarditis, my object has been to draw attention more closely to a class of cases, the real nature of which is so likely to be overlooked; and to enforce the necessity of an early examination of the heart, by means of auscultation, in all obscure and intractable affections of the brain and spinal cord. The advantages of such an examination of the heart are rendered very conspicuous by a comparison of the relative mortality of the cases where the cardiac disease was detected, and of those where it was not suspected during life: of the 16 recorded cases, 11 proved fatal, and only 5 recovered. In four of these successful cases (VII., VIII., IX., XI.) the diagnosis of cardiac disease was satisfactorily established; in the fifth (X.), cardiac disease was only suspected. In only two of the eleven fatal cases (II., XIII.) was an affection of the heart detected during life; in one other (VI.), disease of the heart was suspected, and in the remaining eight fatal cases (I., III., IV., V., XII., XIV., XV., XVI.), there was no suspicion of acute disease of the heart until it was revealed by examination after death.

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* Op. cit.

I shall conclude this section with some observations upon the treatment of these cases of acute inflammation of the heart, complicated with nervous symptoms.

It appears that only five of the sixteen cases detailed in this section terminated favourably. In four of these (VII., VIII., IX., XI.), the cardiac disease was detected at an early stage of the case, and remedies were employed to control the exciting cause of the nervous symptoms. These remedies were the abstraction of blood by venesection, and by cupping from the region of the heart, the application of blisters over the cardiac region, and the free administration of mercury combined with opium, so as to produce mercurial affection of the mouth. In two other cases (II., XIII.), the disease of the heart was, indeed, detected during the life of the patient, but nevertheless it ended fatally. It will be instructive to inquire into the cause of the want of success in the treatment of these two. In the one (Case II.), although a slight affection of the heart was discovered on the day of the patient's admission into St. Bartholomew's Hospital, still it was not until two days afterwards, and only twenty-four hours before the boy's death, that the physical signs indicated the existence of pericarditis, and it was only from that period that the active remedies above described were employed to subdue the cardiac inflammation; but they proved ineffectual.

Upon the other occasion (Case XIII.), the pericarditis was only discovered the day before the patient's death, when his system was already exhausted by general dropsy of some weeks' duration, and by five days' continuance of the peculiar urgent nervous symptoms, which sometimes indicate the presence of active cardiac inflammation. The want of success in the treatment of these two cases is sufficiently accounted for by the late period at which the cardiac disease was detected.

Some writers have expressed an opinion, when peculiar nervous symptoms appear in the progress of rheumatic carditis or pericarditis, that they arise from a metastasis of the morbid action to the membranes of the brain and spinal cord. It will therefore be interesting to inquire into the result of those cases where the treatment has been exclusively directed to these nervous centres.

In Cases I., IV., V., XIV., XV., the treatment was principally, if not wholly, directed to the brain and spinal cord. It consisted of abstraction of blood and other remedies, to control inflammation in those parts, but without arresting the progress of the symptoms. The examinations of the bodies of these patients showed that in only one instance (Case XV.), was there any trace of morbid action going forward in the nervous centres.

In the four remaining cases (III., VI., XII., XVI.), the treatment consisted either of remedies usually termed antiphlogistic, or it is not particularly described by the authors by whom the cases are related.

From the foregoing analysis it is evident, that an early diagnosis of the cardiac affection is a very important element to ensure a successful termination to the case. It also appears that the plan of treatment, which alone was attended with success, consisted of a combination of general and local depletion, with the application of blisters to the cardiac region, and the free use of calomel combined with opium.

I will add a few more observations upon each of these remedies, in the treatment of acute inflammations of the heart; but my remarks will apply principally to cases of pericarditis, because it is generally in connection with this affection that we meet with the symptoms of nervous irritation.

In the treatment of cases of active rheumatic pericarditis, I rarely find it necessary to abstract blood by venesection, while I resort to repeated depletion from the region of the heart by cupping-glasses applied between the base of the left scapula and the spine, or by the application of leeches near the left mamma. It is probable I might resort to venæsection more frequently, as a remedy in pericarditis, if I had generally to treat patients with more stamina than is usually presented by the inhabitants of this metropolis, or if these cases came under my observation from their very commencement.

It has been a surmise with some practitioners, that the abstraction of blood by venæsection in the course of rheumatic fever, has a tendency to favour cardiac inflammations. My experience does not coincide with such an opinion. Unfortunately, too many of the rheumatic patients who come under my care at St. Bartholomew's, enter the hospital with cardiac inflammations already in progress, although they may have undergone no treatment prior to their admission beyond a few doses of aperient medicine. Many patients, also, who have entered the hospital with such slight symptoms of rheumatic fever as not to require any active remedies, have, after the expiration of a few days, exhibited unequivocal symptoms of endocarditis or pericarditis. Such facts lead me to the opinion, that the supervention of cardiac inflammation, upon abstraction of blood by venæsection, in a case of rheumatic fever, cannot be regarded as an effect of this remedy. On the contrary, I am rather disposed to consider the appearance of cardiac inflammation after venæsection, as attributable to the persistence of those urgent symptoms of the disorder, which had induced me, in the first instance, to resort to this abstraction of blood.

There is no remedy upon which, after local depletion, I place more reliance, in the treatment of pericarditis, than a blister applied over the cardiac region. In the slighter cases, a marked improvement ensues upon the action of a blister, and, in the more severe cases of pericarditis, characterised by hurried respiration, anxious countenance, great dyspnœa, short cough, frequent small pulse, with the physical signs of pericardial effusion, the amendment consequent on the application of a large blister to the sternum is so rapid and striking, that it can hardly be realised by those who are not in the habit of contemplating such cases.

In all cases of pericarditis, excepting in patients affected with tubercular disease of the lungs, or in the very anæmic and cachectic, I employ mercurial preparations as freely as in acute inflammations of other parts. An ingenious writer* has affirmed that the employment of this mineral in the treatment of rheumatic affections of the heart is based upon a false analogy between these specific and idiopathic inflammations of similar parts. I must confess, that, to my comprehension, the analogies between rheumatic and other inflammations of the pericardium or endocardium are sufficiently close to justify the employment of so powerful a combination as calomel combined with opium, to reduce the inflammatory actions. My experience fully confirms the propriety of employing this combination. I believe my method of prescribing these drugs does not differ from that in common use among physicians of the present day. I administer a few large doses of calomel, varying from five to ten grains, combined with a grain of opium, and then continue half the dose of the same combination at moderate intervals, until the urgent symptoms abate, or the mouth becomes distinctly affected by the mercury. I sometimes, although rarely, order mercurial inunction, together with the internal administration of the calomel.

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* Library of Medicine—*Art. Rheumatism.*

EXPLANATION OF THE PLATES.

The following coloured drawings are designed to exhibit the relative degrees of congestion of the vessels of the head, both external and internal, in animals that have died under different circumstances.

The accuracy of anatomical details has been deemed of less importance than the faithful representation of the varying degrees of vascularity of the encephalon exhibited in the several experiments.

Plates I. and II.

These drawings represent the upper surfaces of the brains of two rabbits. The one animal (A) was destroyed by hæmorrhage; the other (B) by strangulation. The contrast between the two heads in point of vascularity, both on the exterior and the interior, is most striking. In the one (A), scarcely a trace of a blood-vessel is to be seen; in the other (B), every vessel is turgid with blood.

Plates III. and IV.

These drawings represent the upper surfaces of the brains of two rabbits. Both animals were destroyed at the same time by prussic acid. The one (C) was suspended by the ears; the other (D) by the hind legs. In the former the gravitation of the blood from the head has left the internal and external parts of the cranium in a complete state of anæmia; in the latter the gravitation of blood to the head has produced a most intense congestion of similar parts.

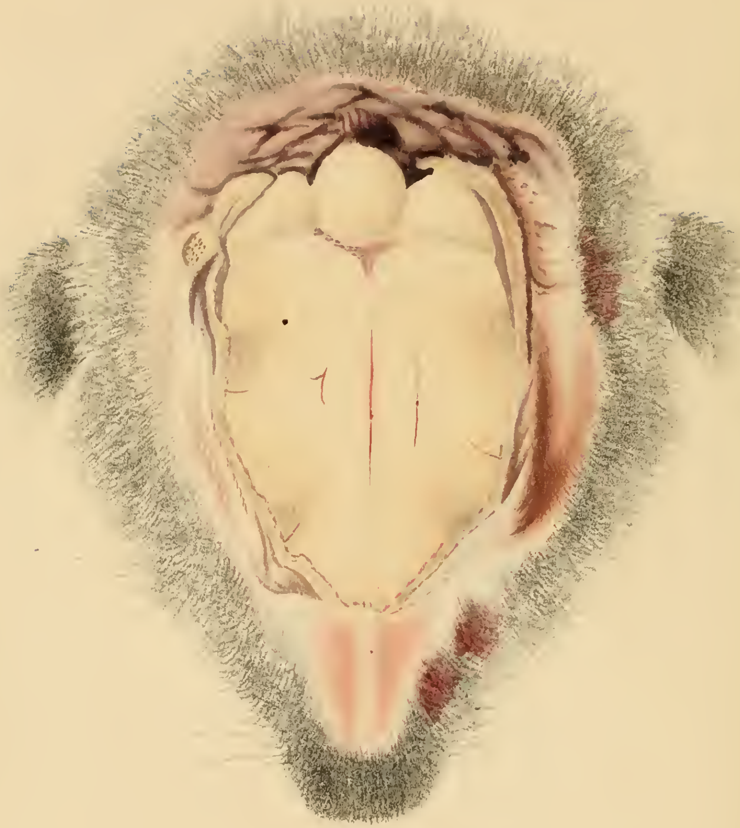
Plates V. and VI.

These drawings represent the upper surfaces of the brains of two rabbits, destroyed by placing ligatures around the trachea. The animal (E) was suspended by the ears immediately after death; the other (F) was laid upon its side. In the former the blood-vessels of the head, especially the external, are depleted by gravitation; in the latter the congestion produced by apnœa is uninfluenced by posture, and may be advantageously contrasted with the congestion produced by strangulation (Plate II. B.)

THE END.

WILSON AND OGILVY, SKINNER-STREET, SNOWHILL, LONDON.

HÆMORRHAGE.



A

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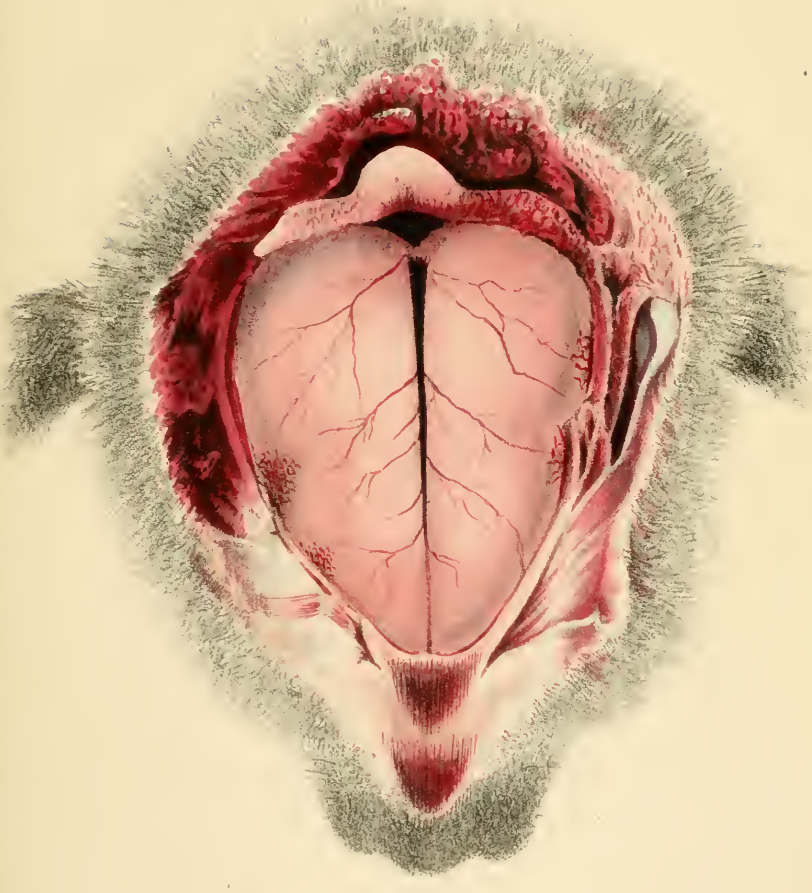
STRANGULATION



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3

GRAVITATION

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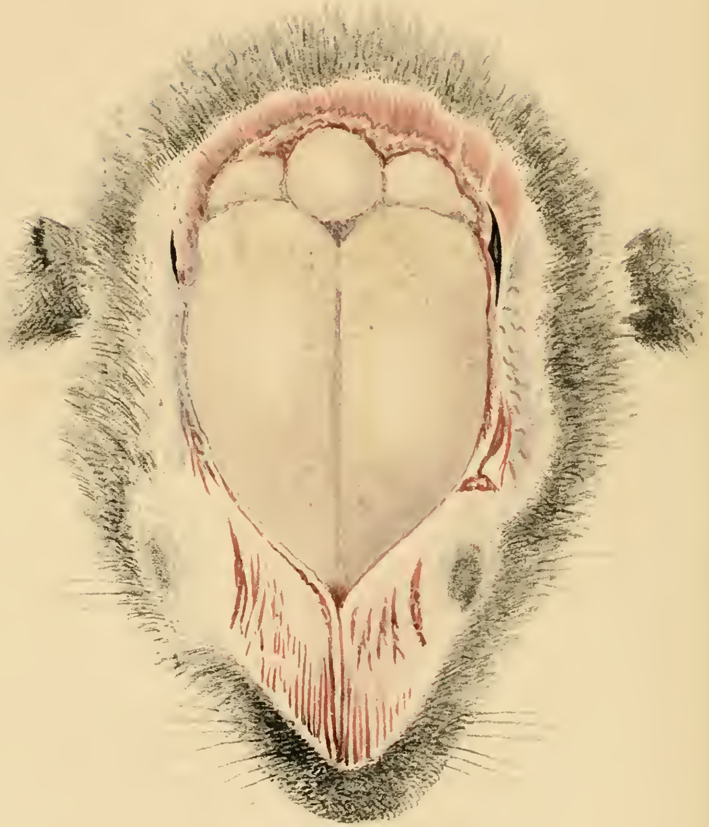

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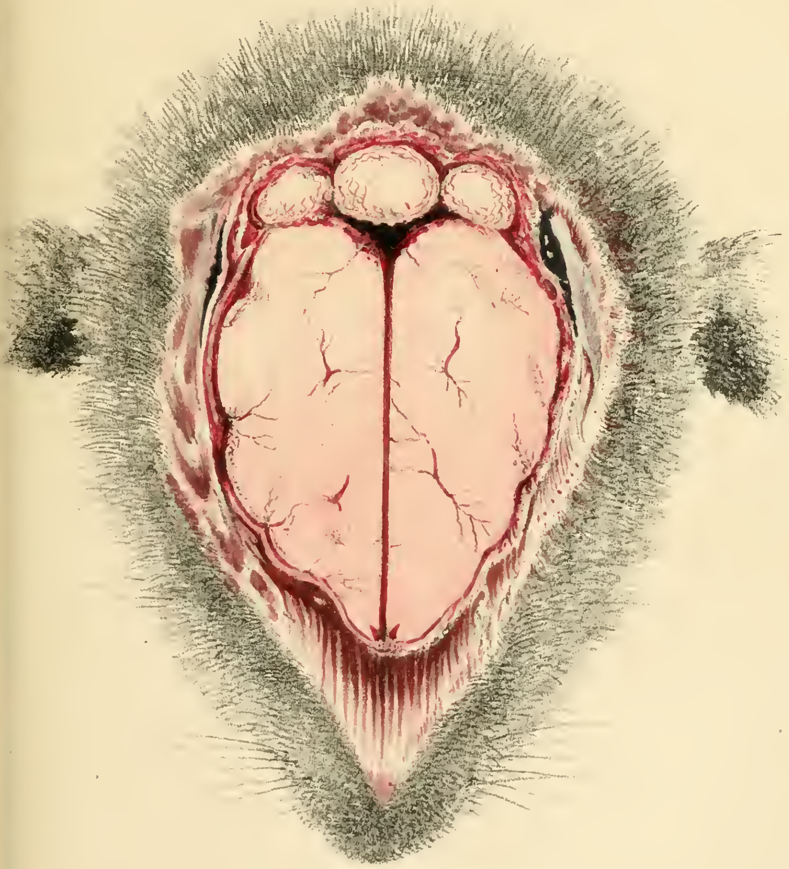

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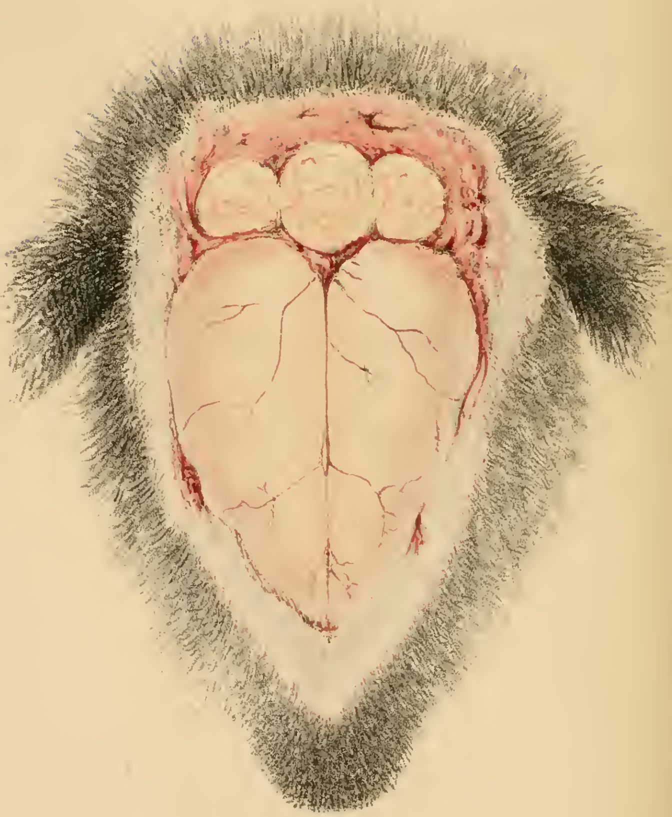
5

APNŒA & POSTURE

SUSPENDED



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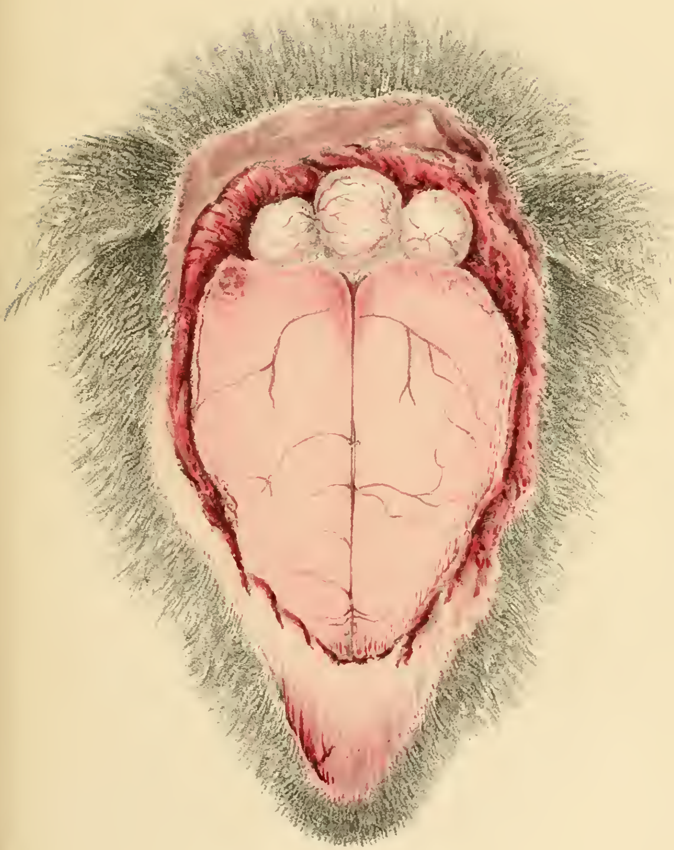
6

APNŒA & POSTURE

HORIZONTAL



F

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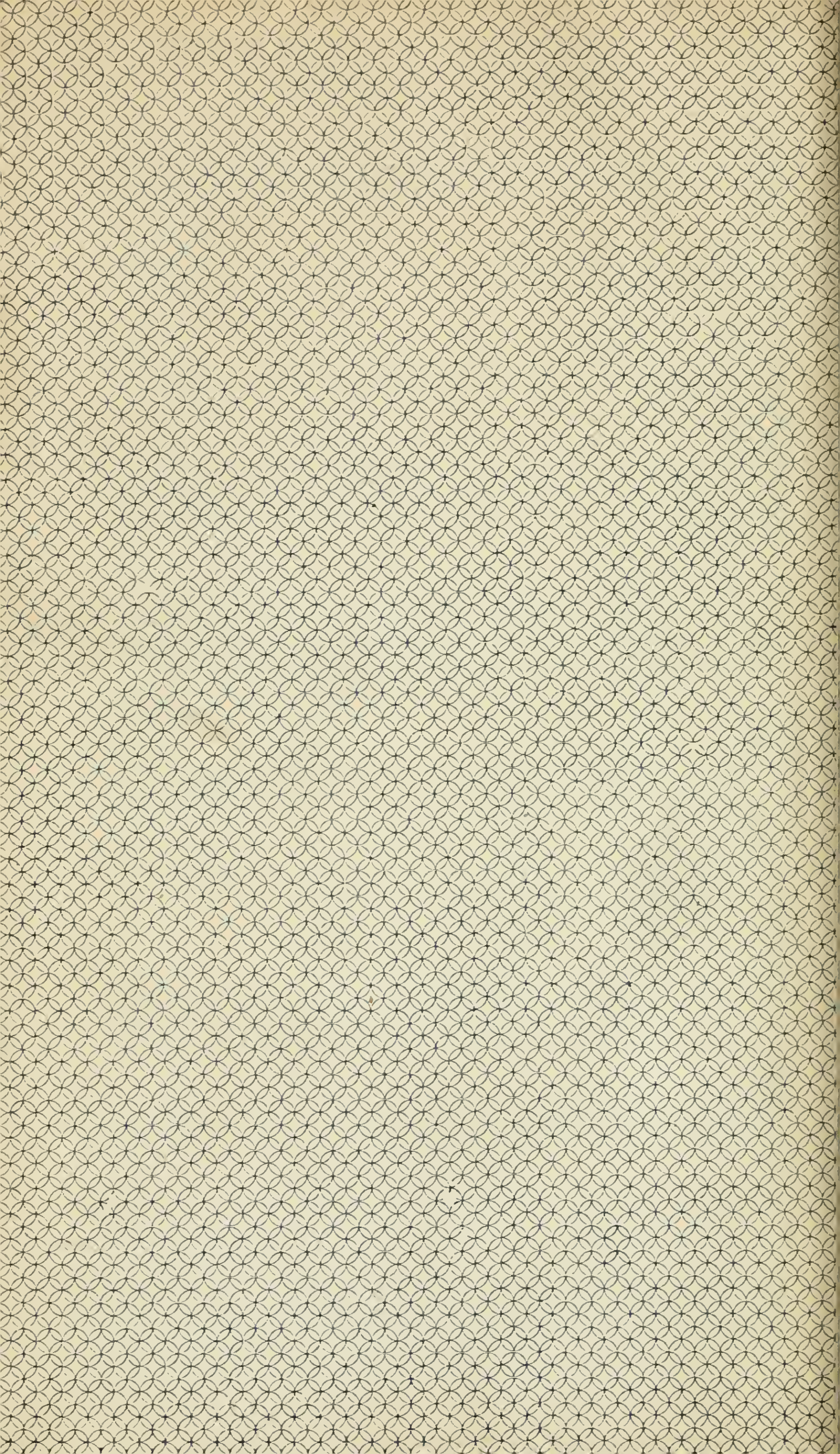

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